Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

FOR ALL POWER ENGINEERS • STEAM, ELECTRICITY AND ALL OTHER POWER ENGINEERING SERVICES

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The PRACTICAL ENGINEER and ELECTRICIAN

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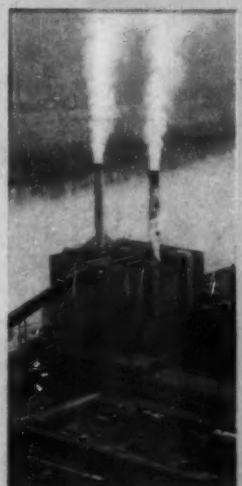
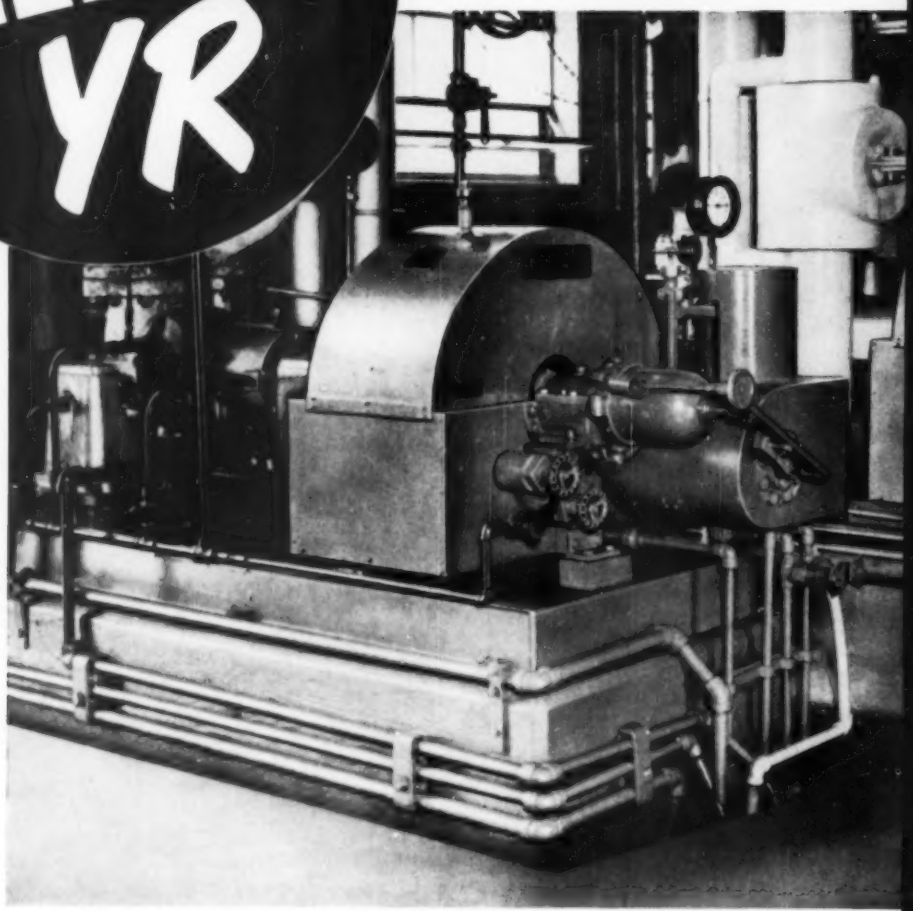
Sunbury Steam-Electric Station



NOVEMBER
1950

TECHNICAL PUBLISHING COMPANY • CHICAGO, ILLINOIS

ELLIOTT YR *the Turbine*



Elliott YR turbines may be furnished, when so specified, with carefully tailored, neat appearing, and readily removable jacketing, as in this installation.

ELLIOTT COMPANY

STEAM TURBINE DEPT.
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Plants at: JEANNETTE, PA. • RIDGWAY, PA.
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that has everything!

1 ADAPTABILITY— Every plant engineer wants turbines tailored to his needs—if he can get them. In the YR, he can—and without sacrifice of standardization. Permissible modifications cover the widest possible range. Actually, eight types of turbines are available on five basic frames . . . one basic design of governor valve, six elective types of governor . . . several types of speed changer, emergency tripping mechanisms . . . gland seal arrangement for condensing operation and for operation with gas . . . with these and a number of other modifications practically any requirements can be met.

2 RELIABILITY— Here is a quality for which Elliott turbines have long been renowned. In the YR, this quality has been further enhanced by improving manufacturing facilities and details of design upon which reliable operation depends.

3 ECONOMY— Added to the operating saving in using a turbine practically built for its specific conditions, is the further direct saving in the reduction in stocking replacement parts due to the interchangeability of wearing parts on all frame sizes. One of the benefits of standardization.

4 REPUTATION— The high standing which Elliott turbines have earned everywhere is the best safeguard an engineer can have to sustain his selection of YR turbines. As one engineer said to another who had been having drive troubles, "Why don't you put in Elliott turbines and stop worrying?" In this he voiced an opinion almost universally held.

Whatever you want in a mechanical drive turbine you can get in a YR. Bulletin H-16 has all the details—write for it.

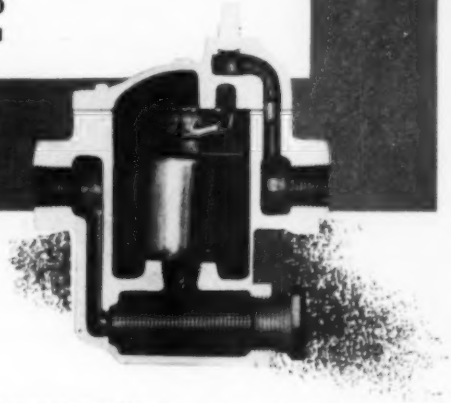
H-729

STEAM TURBINES • GAS TURBINES • GENERATORS • MOTORS • CONDENSERS
FEEDWATER HEATERS AND DEAERATORS • STEAM JET EJECTORS
CENTRIFUGAL BLOWERS • TURBOCHARGERS FOR DIESEL ENGINES
TUBE CLEANERS • STRAINERS • EXPANDERS • FILTERS

Money Saving Steam Traps with the Strainers *Built Right In*

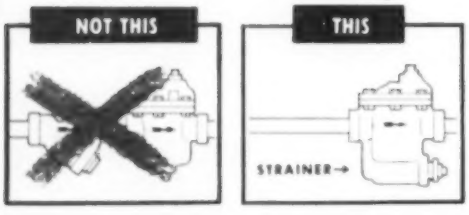
. . . Now Available in Two Sizes

FIRST—THE ARMSTRONG No. 880
AND NOW—THE LARGER No. 881



VITAL STATISTICS

	No. 880	No. 881
Pipe Connections	½" or ¾"	½" or ¾"
Operating Pressure	150 psig	250 psig
Capacity, lbs. per hour continuous discharge	450-690	760-1060
Height	5⅜"	7 1/16"
Diameter	5"	5"
Weight	5 lbs.	6 lbs.



AN ECONOMICAL steam trap for draining small equipment naturally has a small discharge orifice. When dirt or scale conditions are bad it is recommended that a strainer be installed ahead of such a trap to avoid clogging.

Either the Armstrong No. 880 or No. 881 trap is a perfect answer for such a condition. In each the strainer is built right into the body, thereby eliminating a separate strainer, extra fittings and considerable installation labor. Best of all, these traps cost less than a standard trap plus a separate strainer. Look over your small trap applications and order the traps you need now from your local Armstrong representative's stock.

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Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

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November 1950

VOLUME 54—NUMBER 11

Notes on This Issue

Duct Sizing

Any engineer who has had to wade through the conventional methods of calculating duct sizes involving friction factors, viscosity factors, viscosity in centipoises, density and all the other items that must be taken into account, will appreciate these two pages. They will give him his answer as accurately as he needs it for practical purposes and well within the limits of accuracy with which the pressure drops and velocities can be measured.

The calculations for various sizes of ducts are reduced to 4 tables from which you read the multipliers A, B and C, put them in the simple formula: Flow = A × B × C and get your answer by simple multiplication or division.

Sunbury Station

The new Sunbury Station of Pennsylvania Power & Light Company is the world's largest station burning pulverized anthracite. It contains two 75,000 kw turbine generators at present served with steam by four boilers, but this station is now being enlarged and is planned for an ultimate capacity of about 500,000 kw.

Capacitor Application Limits

Engineers understand methods for correcting low power factor, but in a specific case it is not always easy to decide just how far to go either in the installation of capacitors or synchronous motors.

It is from this standpoint that Mr. Stangland attacks the problem. By means of a nomogram (an alignment chart) he makes it possible for anyone easily and quickly to determine what the limits are in the installation of capacitors.

Every operator of electrical equipment will find this article of interest and of value.

Gas Burning Diesel Cuts Power Cost 50 Per Cent

This Diesel story describes a rather unique installation at Elkhorn, Wisconsin. It is probably the only gas-burning Diesel engine in Wisconsin, since natural gas is not natural to Wisconsin and few pipe lines have been constructed.

Installed in 1949 this engine has shown remarkable savings in fuel costs and cost figures are given in the article.

Oakley "Colony" Power House

Over the years the idea of centralized power plants to serve groups of factories has frequently been discussed and a number of relatively small ones has been developed. The power house described in this article is owned and operated on a pro-rata basis by 7 manufacturers and has grown to a 300,000 lb. per hour capacity.

The story tells the development of the Colony Power House from small beginnings to the present layout of 5 modern steam generating units fired by underfeed multiple-retort stokers.

The Practical Engineer and Electrician

The P E & E Section this month has another fine article on refrigeration practice by George Holman. This time he describes in detail the precautions that must be taken in blowing down refrigerating systems. He tells it as only a good practical man can.

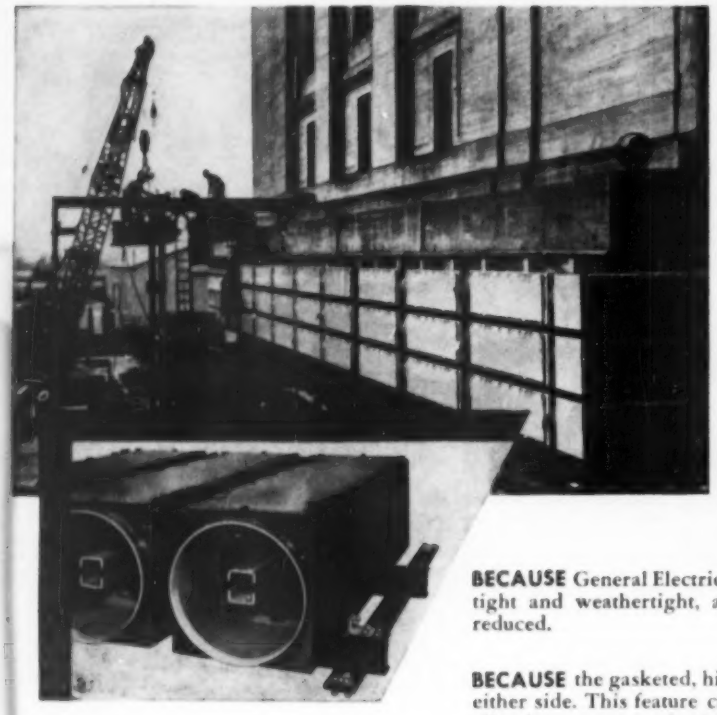
How thick does it pay to insulate? Enough is not too much. There is an economic thickness of insulation that should be used on piping and other power equipment and this article shows how to determine that thickness.

Mr. Paul Schmidt, this month, in his series of fuel oil, discusses the flash points of various oils and what these flash points should mean to the user of fuel oil.

11 of the 16 largest turbine-generators*

use

GENERAL ELECTRIC ISOLATED PHASE BUS RUNS



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15 and 23 kv
1200 to 7000 amperes

Your G-E Sales Representative has complete information about isolated-phase bus runs. Ask him for a copy of GEA-5460, a 28-page publication that will aid you in planning your bus runs, or write to *Apparatus Department, General Electric Company, Schenectady 5, New York.*

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BECAUSE the gasketed, hinged covers can be opened from either side. This feature cuts inspection time and costs by allowing access to the interior of the run from the most convenient position. Cover lugs release the cover without removal of bolts. The cover is swung open on either one of two sets of hinges.

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*Installed and planned, rated 6000 amperes and over.

GENERAL ELECTRIC

ENGINEERS' PREVIEW

A NEW USE for sound to measure the velocity of water, was described by W. B. Hess and S. K. Waldorf, senior test engineers, Safe Harbor, Pa., Water and Power Corp., and R. C. Swengel, York, Pa., consultant, before the Middle Eastern District Meeting of the AIEE. They said their experiments by ultrasonics of a method of determining the velocity, originally devised by Mr. Swengel, appeared applicable to large bodies of water and may lead to applying the method to large scale measurements in the discharge of turbines at hydroelectric plants.

★ ★ ★

MASSACHUSETTS is leading the nation in the adoption and use of rubber in roads to reduce the costs of maintaining its highways, cut down traffic noise and increase riding comfort.

A 5½-mile, four-lane "rubber" highway, the longest of its kind in the world, was formally opened to traffic September 1. Heretofore, the use of rubber in roads has been limited to test sections ranging from 100 ft to 1½ miles long.

The new "rubber" highway is on the old Boston Post Road, now U. S. Route 1, the main highway running from Maine to Florida. It extends from North Attleboro, Mass., south to the Rhode Island State line. It was laid over an old and badly patched concrete base at an approximate cost of $200,000 and is constructed of a combination of asphalt and a new meltable rubber compound called Surfa-Sealz, developed by United States Rubber Co. Highway officials expect it to give at least twice as much wear as standard asphalt re-surfacing material.

★ ★ ★

LOOKING toward its 50th anniversary, Pioneer Service & Engineering Co. has prepared a 16-page booklet that traces its history and describes its present-day activities. It has designed and built public utility systems, office buildings, warehouses and other industrial facilities throughout the United States and Mexico; and it serves in consulting capacities on technical, operating and corporate matters. It is an independent organization, employee owned and employee managed.

Copies of the booklet may be obtained by writing to Fred C. Kellogg, president, Pioneer Service & Engineering Co., 231 South La Salle St., Chicago 4, Ill.

★ ★ ★

CARNEGIE Institute of Technology has announced that examinations for ten Westinghouse scholarships worth a total of $28,500 will be given on March 10, 1951. Examinations for the scholarships, sponsored annually at Carnegie by the Westinghouse Educational Foundation, will be given by the College Entrance Examination Board in all parts of the nation.

The scholarships, worth $2,850 each, cover four years' tuition and include cash grants in the freshman and sophomore years. Each year ten of these awards are given to highest ranking secondary school senior men for study at Carnegie in engineering, science or industrial management. The competition is opened to men who graduate in the upper quarter of their class between January and September 1951.

Students who want to try for the Westinghouse scholarships must write Carnegie's Chairman of Admissions in Pittsburgh for application forms before December 1, 1950.

MANY READERS of the article "Fire Your Gas Safely," *Power Engineering*, September 1950, page 76, have asked for more details on the gas safety control system described in that article. It so happens that the Factory Mutual Engineering Div. of Associated Factory Mutual Fire Insurance Co., 184 High St., Boston 10, Mass., which originally developed the system, has recently issued a Bulletin No. 14.56, giving a great deal more detail of the equipment and its uses than could be included in our article. The Factory Mutual Bulletin includes details of the gas safety cocks, a number of diagrams of their application to burner systems, with and without pilots, and detailed directions for testing the system. For copies of the bulletin write direct to Factory Mutual at the address indicated. They will be very glad to supply them.

For engineers who have to mix into industrial furnace problems, the organization has another bulletin No. 11.37 on Dowtherm Heat Transfer Systems; another 14.70 on Flammable Atmosphere Hazards of Special Atmosphere Furnaces; and another 14.20 on Preventing Fuel Explosions in Gas and Oil Fired Industrial Furnaces.

★ ★ ★

ALLEN B. Du Mont Laboratories, Inc. announced the delivery this week of a color television system equipment to Paramount Pictures Corp. This equipment is the first production unit of the non-broadcast (industrial) high-fidelity system of which a development model was shown at the Institute of Radio Engineers Convention in New York last March. Since that preliminary showing, Du Mont engineers evolved the system to its present commercial form and the equipment is now being produced and offered to industry for applications in the non-broadcast field. Industrially, it may be used for the remote viewing of phenomena dangerous to personnel, or where, for practical purposes, eye-viewing is not feasible. Scenes reproduced in full-color are essential in many applications, while many times more effective in others.

★ ★ ★

IF IT HAS not already been done, look for the Department of the Interior which will supervise power controls in any mobilization program to request power groups to suggest names of conferees to plan organization of a power advisory council and establishment of a power controls agency. Consultants have been appointed to assist Interior Secretary Oscar L. Chapman as follows: C. B. McManus, president of Georgia Power Co.; Richard K. Lane, president of Public Service Co. of Oklahoma; Chandler W. Jones, president of Northampton Electric Lighting Co. and assistant vice president of the New England Electric System; Daniel V. McNamee, Jr., vice president of George R. Cooley & Co.

Edward Falck, Director of the National Security Resources Board's Office of Energy and Utilities and former wartime director of OWU is an important figure in the group, and others are Robert Blum, assistant director of OEU; D. L. Marlett, of the Department of the Interior; Herschel Jones, chief of Bonneville Power Administration's branch of power requirements and former assistant to Falck at OWU; and Alfred C. Wolf, acting executive assistant to Chapman for controls.

MONITORING instrument which detects unsafe temperatures in machinery, announces the fact and records the information, is about to emerge from the laboratory. This instrument was described recently in an AIEE paper by W. E. Belcher, Jr., of the Minneapolis Honeywell Instrument Co.

Its most predominant application is for continual checking of bearing temperatures in rotating machinery. Tube and boiler temperatures in central stations are also of prime importance. Speeds required here run from two to ten seconds per point and the systems required are both total and selective logging systems.

Other applications are for flue gas temperatures, atomic pile temperatures, catalytic cracking unit temperatures, flows in petroleum processing units, and strain measurement. The speeds of scanning required in these cases are generally slower than one point per second.

★ ★ ★

A FORWARD step in the direction of standardization was taken when, on August 11, 1950, official information was released that most of the control manufacturers are able to supply flanged control valves conforming to the face-to-face dimensions shown in the attached table. This accomplishment is a result of the joint effort of the National Steam Specialties Club and the ISA. Full details are available from the latter organization: Address—Instrument Society of America, 921 Ridge Ave., Pittsburgh 12, Pa.

UNIFORM STANDARD FACE TO FACE DIMENSIONS OF FLANGED CONTROL VALVE BODIES—SUGGESTED BY THE NATIONAL STEAM SPECIALTIES CLUB

Pipe Size Inches	125 Psi Iron 150 Psi Steel See Note 1	250 Psi Iron 300 Psi Steel See Note 2	600 Psi Steel See Note 3
½		7½	8
¾		7¾	8½
1	7¼	7¾	8¼
1½	8¾	9¼	9⅞
2	10	10½	11¼
2½	10⅞	11½	12¼
3	11¾	12½	13¼
4	13⅞	14½	15½
6	17¾	18⅞	20
8	21⅞	22⅞	24

Note 1 — Cast iron bodies with 125 psi ASA B16A-1939 flanges, and steel bodies with 150 psi raised face ASA-B16E-1939 flanges.

Note 2 — Cast iron bodies with 250 psi ASA B16B-1944 flanges, and steel bodies with 300 psi raised face B16E-1939 flanges.

Note 3 — Steel bodies with 600 psi raised face ASA B16E-1939 flanges.

★ ★ ★

TECHNIQUES of Preparing Major BLS Statistical Series, a compact presentation of the methods by which the U. S. Labor Department's Bureau of Labor Statistics compiles its continuing series of figures, is now available in a 72-page Bulletin No. 993, from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at 40 cents a copy. The notes are written for the users of the material. The presentation is largely narrative, with incidental use of statistical formulas. The notes not only explain procedure but give an indication of the statistician's problems in conducting specific surveys.

THE ELECTRIC INDUSTRY is in even better shape to meet the present defense emergency than it was when the nation began to get ready for World War II, L. V. Sutton, President of the Edison Electric Institute has reported to W. Stuart Symington, Chairman of the National Security Resources Board.

There will be plenty of power to meet the needs of the country, Mr. Sutton said, in his letter to the NSRB Chairman, provided that "no government limitations are imposed which would prevent the completion of the construction program now under way."

This year, Mr. Sutton told Mr. Symington, the electric industry will have a total generating capability of 67,500,000 kw, which is nearly double what it had at the beginning of 1941. The current utility construction program will add another 12,000,000 kw of generating capacity by the end of 1952. In addition, the country's electricity production resources include 13,500,000 kw of generating capacity in major industrial plants.

Nearly four times as much new generating equipment is on the power lines today as there was in 1940, Mr. Sutton noted. As of the present, he explained, 30,000,000 kw of the industry's generating equipment is less than 10 years old, with all the advantages of economy of operation and relative freedom from mechanical breakdown possessed by modern machinery. In 1940 only 8,000,000 kw had been installed within the preceding 10 years.

This year reserves total 9,000,000 kw. They can, if necessary, generate more than 50,000,000,000 kwhr a year. A greater use of operating capacity through second and third shift operation of industry would make available at least another 50,000,000,000 kwhr a year. This would represent an increase of one-third in presently available energy from the resource we now have, and would enable us to nearly double our present use of electricity in major industries.

In this connection, however, Mr. Sutton observed that the great reservoirs of unemployed and the idle industrial capacity that existed in 1941 are not available today. Instead, men and supplies for defense work must be diverted from non-essential industries. This shift will tend to reduce the demand for power for such purposes.

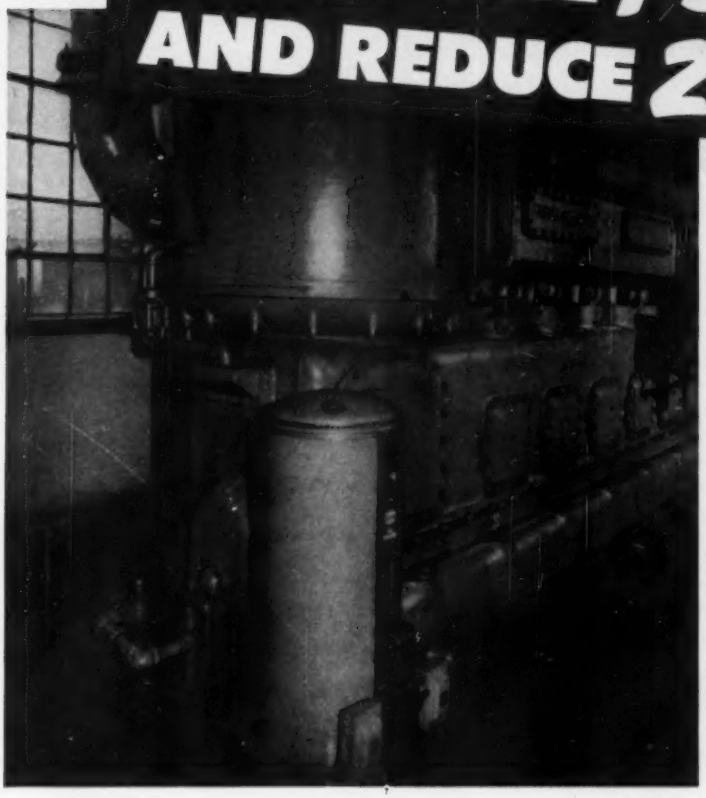
★ ★ ★

UNIQUE SYSTEM of pre-casting concrete foundation grade beams and curtain walls to speed construction and lower the cost of a large industrial plant has been announced by the Wigton-Abbott Corp., engineers and contractors. The process was first used on a large scale in the construction of the 17-acre plant being completed for the Continental Can Co. near Pittsburgh, Pa.

All precasting was done on the site. Curtain wall slabs and foundation grade beams were formed by pouring concrete on a flat, treated concrete surface with removable edge forms. Steel inserts in the concrete were provided to facilitate handling and setting of the slabs and beams and for fastening to the columns.

The beams were fitted between the piers to grade level and the slabs set atop the beams to form a curtain wall up to the first story sill. Slag was used as back fill against the grade beams to within six inches of the finished floor. The substantial savings made by elimination of the conventional form work far outweighed the cost of handling and setting the precast concrete. The desired surface finish was readily obtained, and the cost of finishing precast slabs was considerably less than the cost of pointing up and rubbing poured-in-place wall after removal of forms.

TAKE 1 STEP AND REDUCE 2 COSTS



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It's light! It's bright! It's right! You see instantly the accurate boiler water level in your Yarway Flat Glass Gage because *the meniscus at water level stands out like a brilliant star . . .* thanks to the new Yarway Type "M" Illuminator.

The Type "M" Illuminator is specially-designed to give maximum brilliance to Yarway flat glass inserts, and to spot the water level over its entire traverse. The superior penetration of its blue-white light cuts through extraneous light, dust particles in the air, and deposits on the gage glasses. Effective over longer distances.

New or already-installed Yarway Flat Glass Gages may be equipped with the Illuminator. Yarway Illuminators may be installed in pairs on four-glass gages.

Get in touch with your nearest Yarway office for further details on this latest Flat Glass Gage development, or write direct to . . .

YARNALL-WARING COMPANY

114 Mermaid Avenue, Philadelphia 18, Pa.

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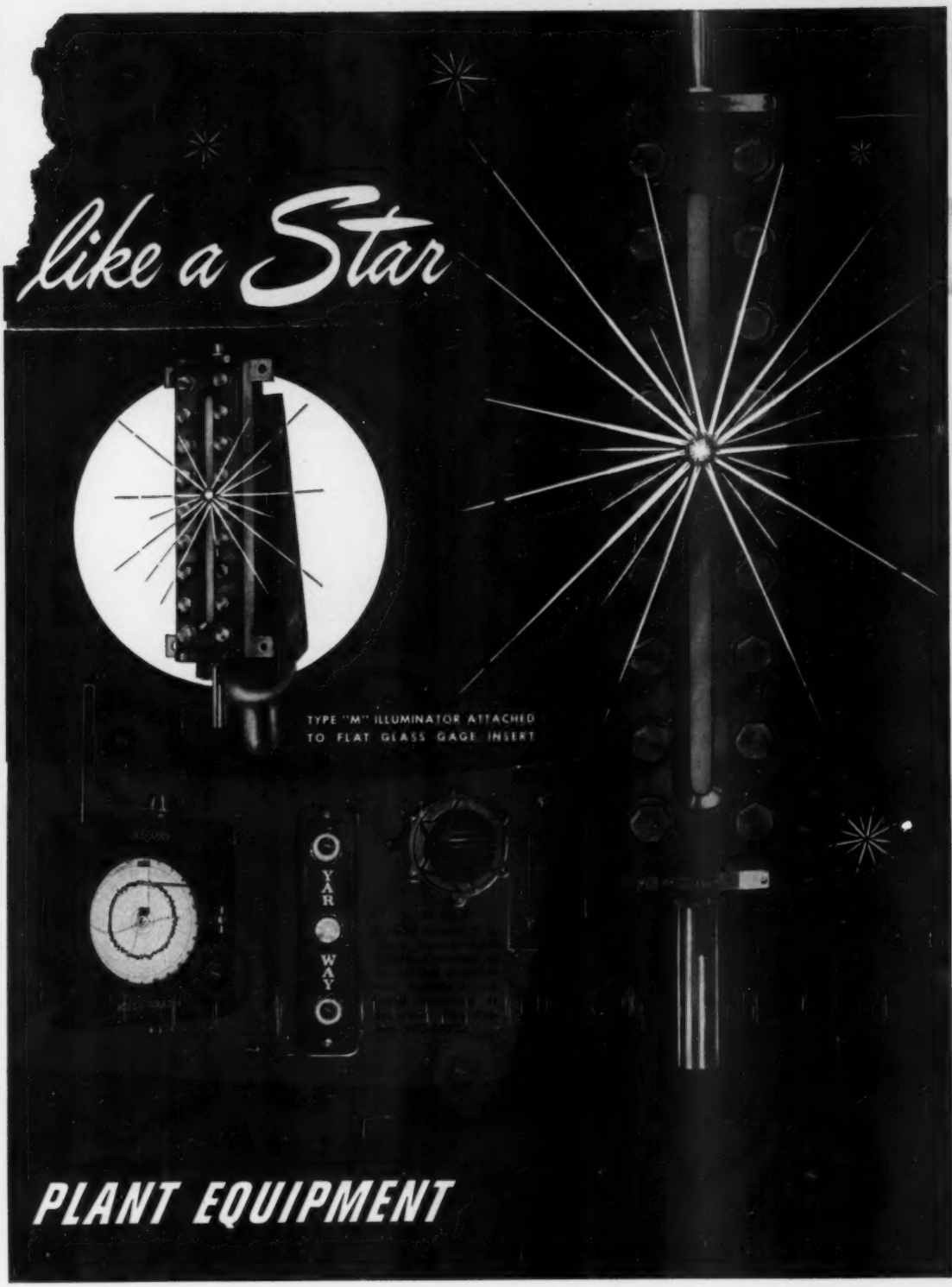
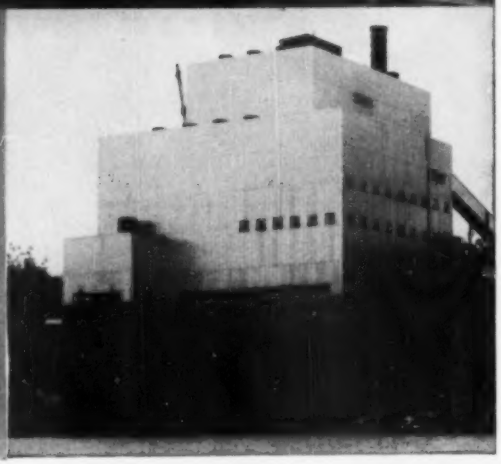
YARWAY STEAM


like a Star
TYPE "M" ILLUMINATOR ATTACHED
TO FLAT GLASS GAGE INSERT
YAR
WAY
PLANT EQUIPMENT

RILEY steam generating and Riley pulverized coal equipment was selected for the new Riverton Station of the Northern Virginia Power Co. Because of the outstandingly satisfactory and efficient performance of Riley steam generating units, Riley units are being installed by many of the country's leading power companies.

Users of Riley equipment will assure you that you will also be very happy with Riley equipment and Riley's handling of your contract, when you join the very definite swing to Riley by power and industrial companies. The performance of Riley equipment in plants warrants a thorough investigation of this equipment by you when you are considering the installation of boiler or fuel burning equipment.



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STOKER CORPORATION, WORCESTER, MASS.

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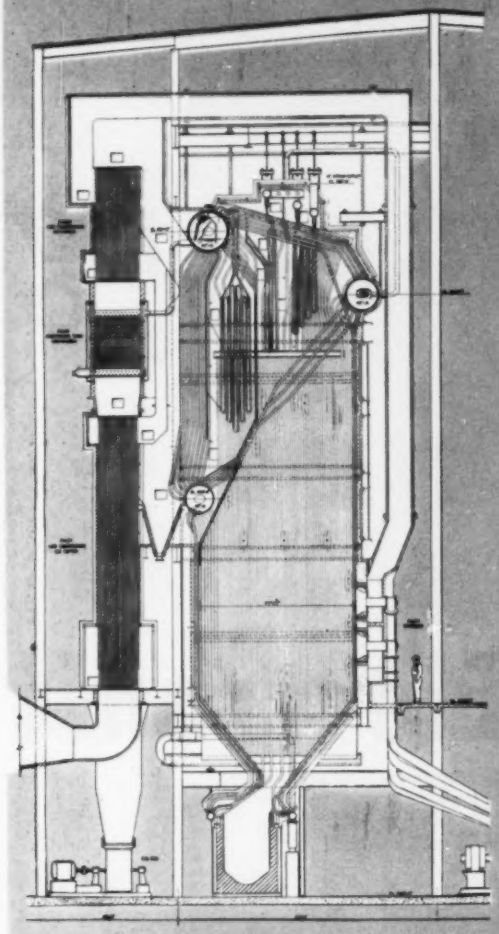
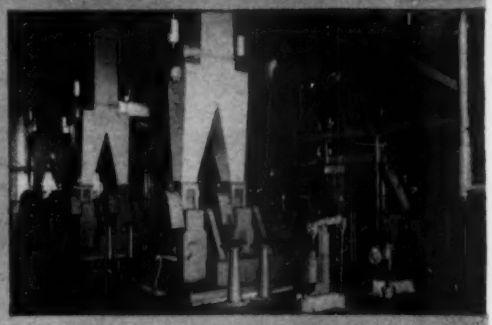
Cincinnati · Atlanta · New Orleans · Memphis · St. Louis · Kansas City · St. Paul · Tulsa · Houston
Denver · Salt Lake City · Los Angeles · Portland · Seattle

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • FLUE GAS SCRUBBERS

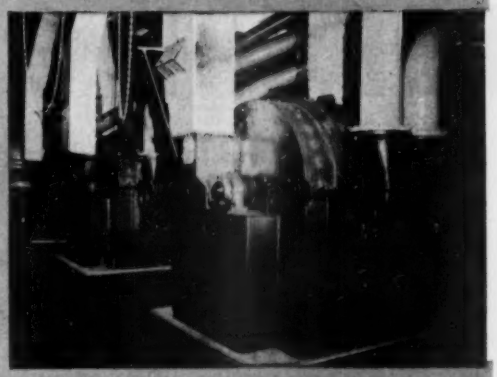
RILEY CENTRAL STATION PLANT



Steam Capacity	350,000 lbs./hr.
Pressure Superheater Outlet	875 psig.
Steam Temperature	900°F
Boiler Surface	14,810 sq. ft.
Water Wall	12,670 sq. ft.
Air Heater	59,000 sq. ft.
Economizer	4,000 sq. ft.
Furnace Volume	21,170 cu. ft.
Heat Release	20,800 B.T.U.
Efficiency	86.6%



View of operating floor showing Riley pulverized coal feeders and burners.



View of the three Riley pulverizers.

Northern Virginia Power Co., Riverton Station
Winchester, Va.
Sanderson & Porter, Engineers
350,000 lbs./hr. 1,100 lbs. pressure, 900°F.
fired by Riley Pulverizers and Burners.

A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly large ... costs

COMPLETE STEAM GENERATING UNITS

ECONOMIZERS WATER-COOLED FURNACES • STEEL-CLAD ... HINGS • AIR HEATERS

... it will pay you to visit modern Riley Installations before purchasing Boiler or Fuel Burning Equipment

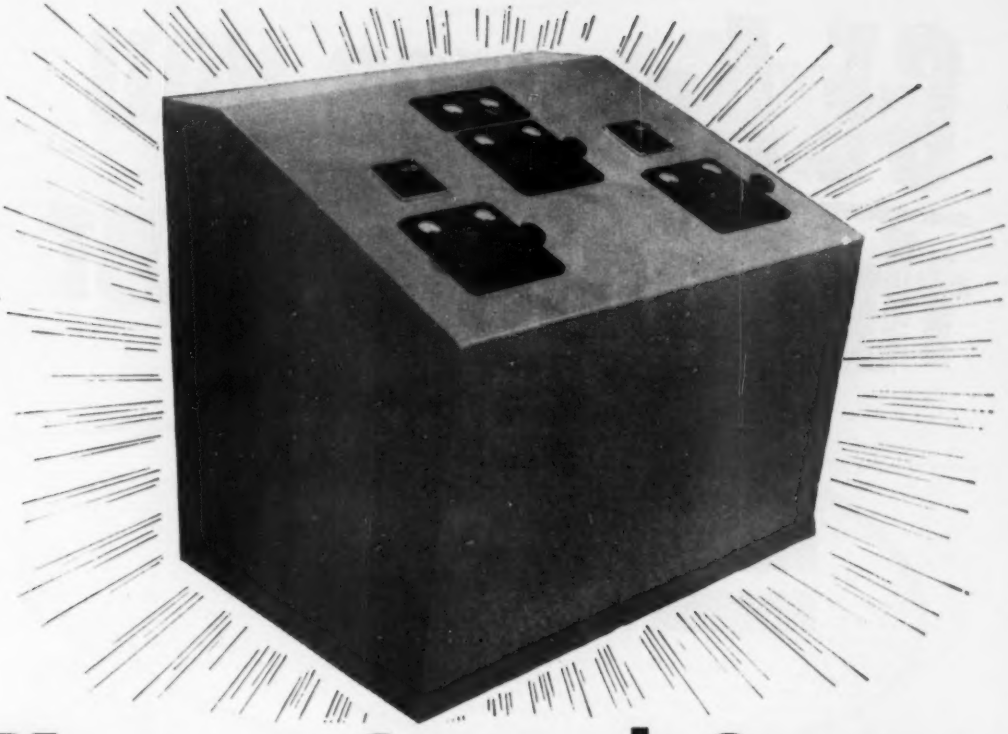
Announcing the new

REPUBLIC Electronic

See It!
Operate It!

VISIT BOOTH NO. 6
NEW YORK
POWER EXPOSITION
NOVEMBER 27 – DECEMBER 2

You are cordially invited to visit Booth No. 6 to see—to operate—to inspect the new Electronic TELEMASTER Control which will be on view for the first time. Our engineers will be available to explain its many unusual features. The complete line of Republic instruments and controls will also be included in the exhibit.



Master Control System

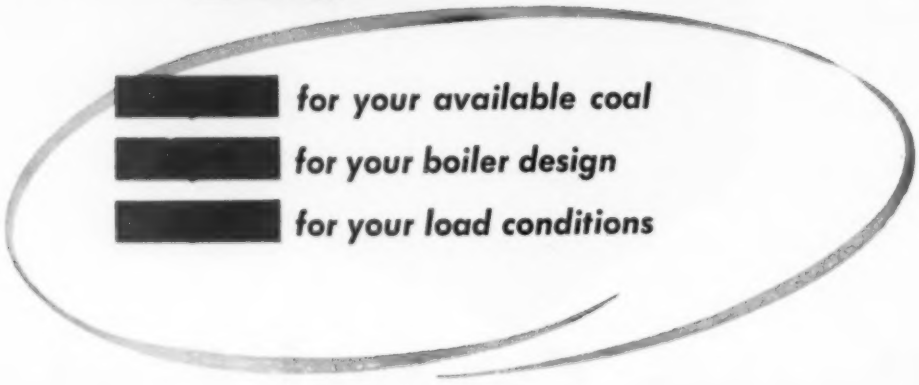
"TELEMASTER"

The new Republic Electronic TELEMASTER Control represents a major advance in the field of automatic control. The TELEMASTER will remotely reproduce, instantly and accurately, a position or a force—perform arithmetical and algebraic calculations—and can be used for multiple operations. Essentially it performs the function of a mechanical link through electrical and electronic means. It is applicable to all types of combustion and process control.

In plants where distances between operating units are great, the lags inherent in the compression effect of a pneumatic master system are appreciable. This effect is frequently sufficient to prevent realization of the full benefits of automatic control. The Republic Electronic TELEMASTER Control has no inherent lag, regardless of distance. This means that centralization of operations can be achieved without any sacrifice of control performance. *Full details sent upon request.*

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

C-E Assures you the right stoker



When you buy a stoker you want the type best suited to *your specific requirements*. You are sure of getting just that when you turn to Combustion Engineering-Superheater. Why? Because a background of more than 20,000 C-E Stoker installations (above residence size) makes available to you an accumulated experience unmatched by any other stoker manufacturer.

In addition, Combustion offers you the most complete line of stokers available today . . . a line that meets every requirement of fuel and load conditions. Therefore, as the manufacturer of *all* types of stokers, Combustion can give you impartial advice in helping you select the *right* stoker.

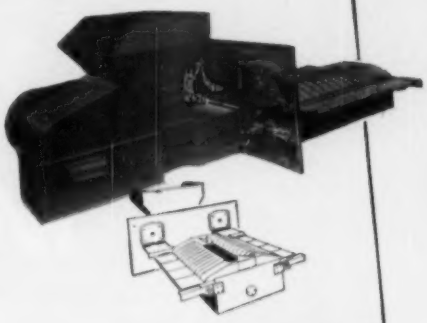
And at today's cost of coal, getting the *right* stoker can pay handsome dividends. For in an average installation the cost of coal used in a year exceeds many times the initial cost of the stoker. Thus the first cost of the stoker is soon absorbed by its saving in coal.

Typical of the complete C-E line are the three stokers on the opposite page – Skelly, Type E and Spreader. Each represents an outstanding value in its respective field. Each reflects the practical knowledge of fuels and operating conditions Combustion has gained through 60 years' experience in stoker design and application.

Day in and day out, all over the country, C-E Stokers are getting operating results as good or better than those anticipated at the time of purchase. In short, they are the *right* stokers for the job they were selected to do. So the next time you are in the market for stoker equipment, talk it over with Combustion before you buy. B-372

COMBUSTION ENGINEERING

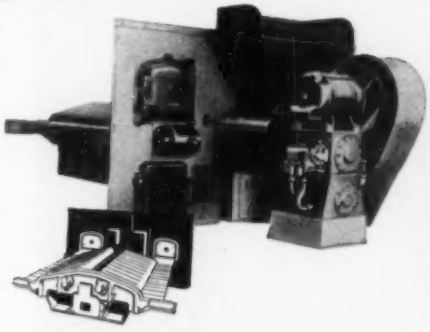
A MERGER OF COMBUSTION ENGINEERING COMPANY, INC. AND THE SUPERHEATER COMPANY



SKELLY STOKER UNIT

Approximate Application Range—20 to 200 boiler hp.

A compact, self-contained underfeed stoker available in designs for burning either anthracite or bituminous coal. An alternate arrangement of fixed and moving grate bars assures lateral distribution of fuel and maintains a clean porous fire. Cantilever dump grates of non-avalanching type simplify ash removal. An integral forced-draft fan, with inlet control, permits positive regulation of air-coal ratio. Sixteen rates of coal feed through variable-speed transmission. Automatic control is standard equipment. Timken bearing equipped. Alemite lubrication throughout.



TYPE E STOKER

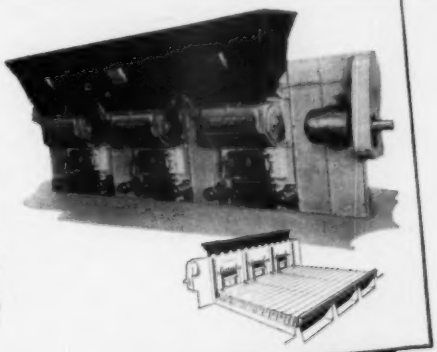
Approximate Application Range—150 to 600 boiler hp.

A single-retort, underfeed stoker designed to burn a wide variety of bituminous coals, particularly those having caking and coking characteristics. The Type E has ram type feed supplemented by a reciprocating sliding bottom. Its grate surface consists of hollow, air-cooled grate bars arranged in an alternately fixed and moving relationship to condition the fuel bed and assure its steady movement to the dump trays which are of the cantilever type. Air supply is under zoned control with provision for introduction of air over the fire. Type E Stokers are available with steam, electric or hydraulic drive.

SPREADER STOKER

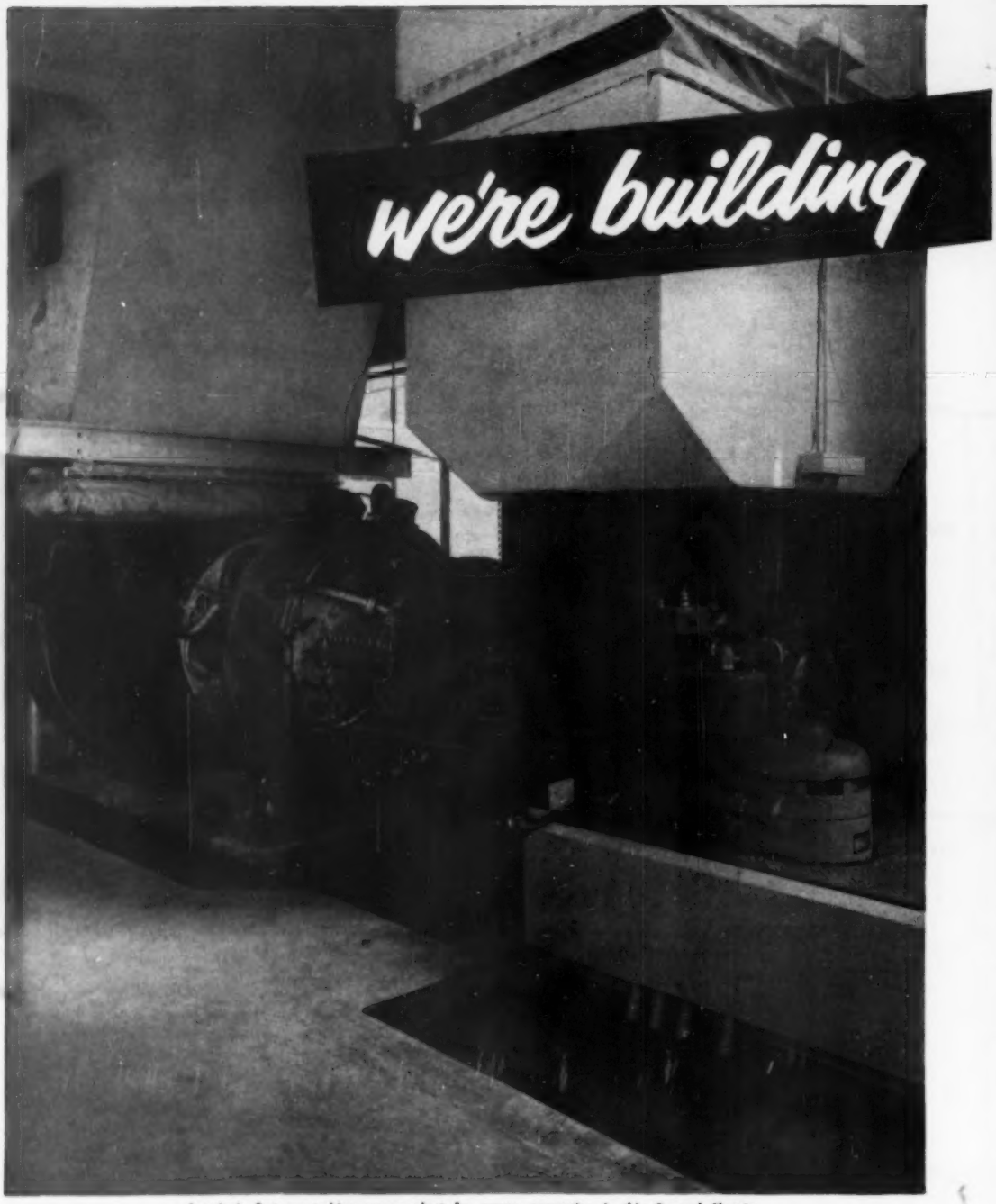
Approximate Application Range—150 boiler hp. up to units producing 200,000 lb of steam per hr, or more.

The C-E Spreader Stoker is available in both dumping grate and continuous discharge types. This simple, rugged stoker is designed to burn a wide variety of coals. Hopper, feeding and distributing mechanism, variable-speed drive and motor are combined in a compact unit. Rotating spreader blades feed coal into the furnace in criss-crossing streams which assure uniform distribution. Fines are burned in suspension and the rest of the coal is burned on the grate. Grate surface is zoned for regulating air admission and to facilitate cleaning. All parts subject to wear are readily accessible for inspection, adjustment or replacement, when necessary. Rate of fuel feed and air supply may be regulated over a wide range and are readily adaptable to automatic control.



— SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.



America's first gas-turbine power plant for power generation is this General Electric 3500 kw unit installed at the Belle Isle Station of the Oklahoma Gas and Electric Co.

MORE Gas Turbines

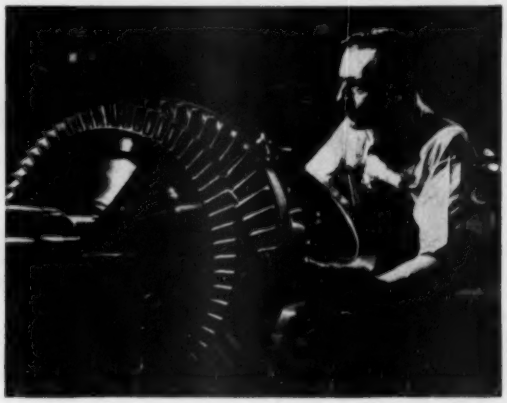
AMERICA'S *New* PRIME MOVER

Three General Electric combustion gas-turbines—the first in America—have been placed in regular service. Full-scale production has begun on several basic designs, and in the next few months, more will be coming off the test stands in G.E.'s newly completed gas turbine factory.

The efficient, reliable and profitable performance record of the units already placed in revenue operation has established the gas turbine as an important prime mover. It offers several unique advantages: Each unit is a complete plant in itself. It is small and compact, easily operated, and requires but a minimum installation investment.

General Electric gas-turbine generators, rated 3500 kw and 5000 kw, are available to meet your requirements. They are backed by the experience that has given G-E steam turbines a position of leadership for more than 45 years. If you're interested in power generation, you'll want the facts about these new power plants. Write for your copy of bulletin GEA-5516, "Gas Turbine Power Plants," today. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

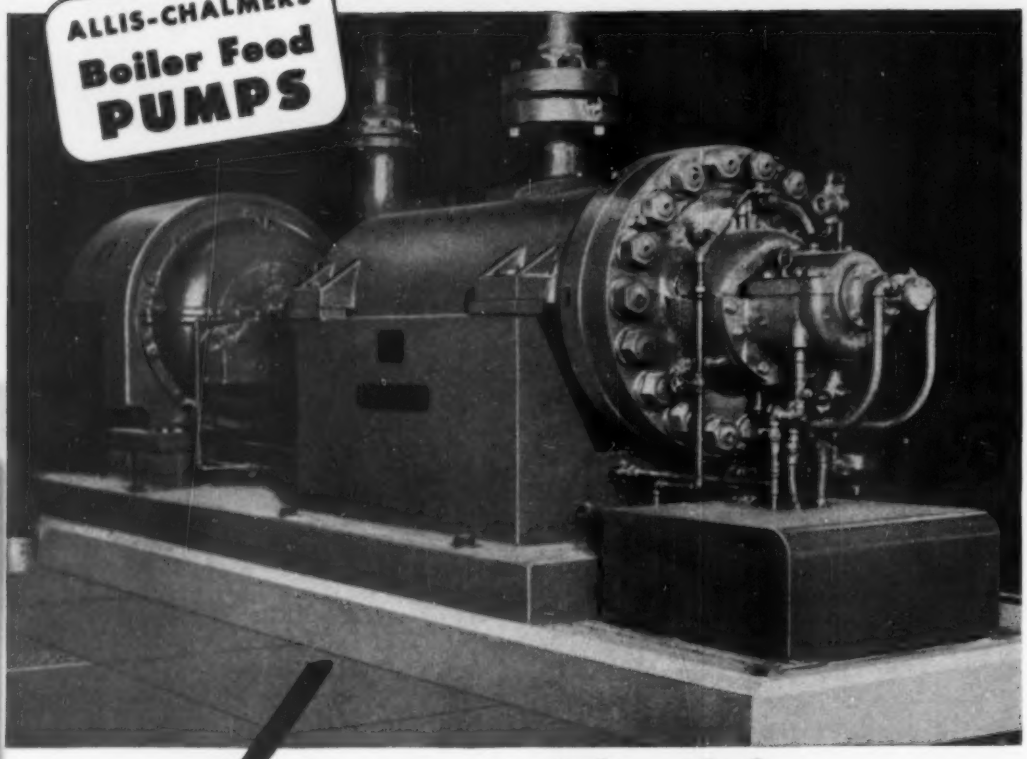
Assembling compressor casings requires the supervision of experienced craftsmen. While many manufacturing experts will "grow up" with gas turbines, responsibility for producing the first units falls on the shoulders of men who have spent years building steam turbines, turbosuperchargers, and jet engines.



Though gas turbines require many components which may be new to the power engineer, the heart of the unit is still the familiar turbine wheel. Designed on principles established by steam turbine experience, this two-stage turbine rotor is given a final micrometer inspection before assembly in a new power plant.

GENERAL ELECTRIC

254-66



Install New Boiler Feed Pump

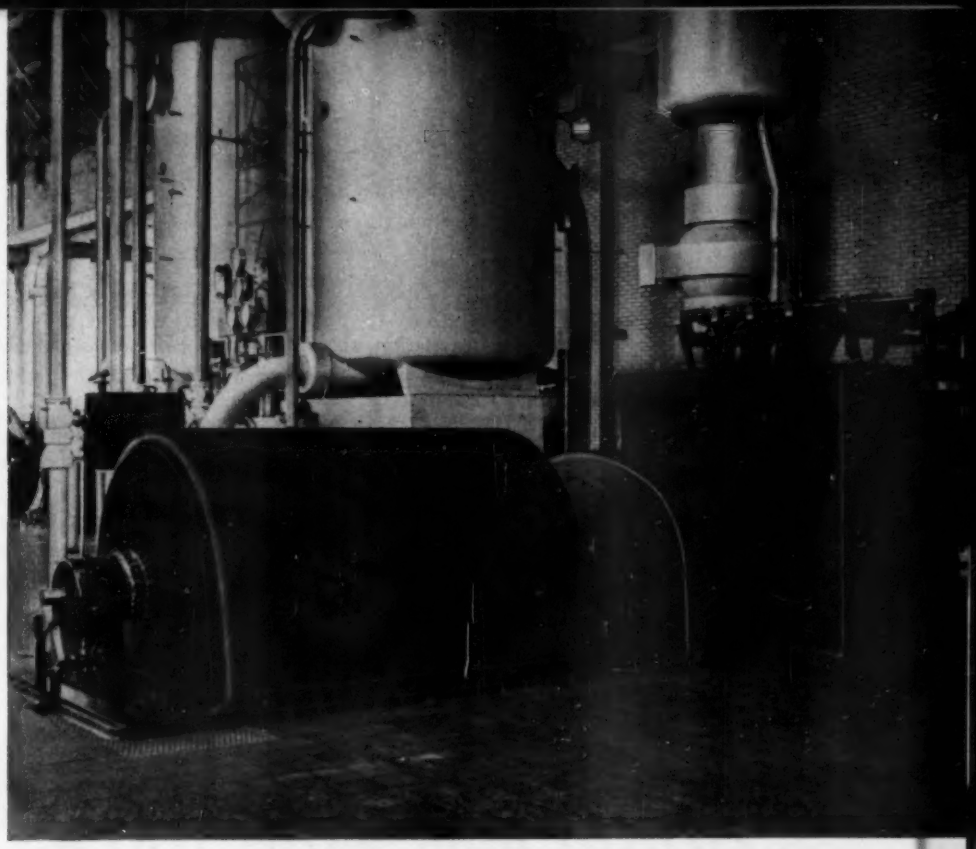
HERE IS ONE OF THREE Allis-Chalmers barrel-type boiler feed pumps installed in one of the East's newest and most modern power plants. Pump is 5" x 5", 12 stage unit with capacity of 227,000 lbs/hr (480 gpm) against 1750 psig head. The motor is an Allis-Chalmers 800 hp 2-pole machine.

This pump was designed especially for the higher pressure ranges becoming more common in the newer plants. The internal split casing joint is held in compression by the full hydraulic pressure of the system assuring a leak-proof joint. Impellers are of single suction, back-to-back design assuring axial balance. Volute casing maintains radial balance. Expansion, especially for quick changes in temperatures, between the inner and outer case is taken care of without the use of an internal flexible gasket member. The Allis-Chalmers pump brings this joint to the outside. Maintenance is easier. Leakage is immediately obvious so adjustment can be made before damage to the pump occurs.

For more information on the new Allis-Chalmers barrel-type boiler feed pump, call your nearest A-C Sales Office or write directly to the factory. A-3209

ALLIS-CHALMERS, 953A SO. 70 ST.
MILWAUKEE, WIS.

ALLIS-CHALMERS



Used 18 years, oil goes right back on the job

● In 18 years of operation, the original fill of NONPAREIL Turbine Oil was never removed from this 2500-KW turbine at the University of Michigan power house. Neutralization numbers always stayed below 0.07 mg. KOH/gm. Tests of oil samples showed no deterioration of the lubricant.

Recently, the turbine was shut down for inspection and general overhaul. Operators drained NONPAREIL from the unit and took a close look at the oil system. *They found no oil deposits, no evidence of rust, and not a sign of corrosion.* The oil itself was in excellent condition and after centrifuging it was returned to the turbine for continued use.

You, too, can obtain such lubrication advantages. By switching to NONPAREIL Turbine Oil, you can eliminate oil acidity troubles and oil system maintenance once and for all. These benefits are not only indicated by the experience of others but are backed by the written guarantee you receive that NONPAREIL will last as long as the turbine and that its acidity will stay below 0.15 mg. KOH/gm.

A Standard Oil lubrication specialist will be glad to supply you with actual case histories of utility operations on which Nonpareil Turbine Oil has reduced lubrication costs as much as 68%. To arrange for his visit, write: Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago 80, Ill.

NONPAREIL
TRADE MARK
Turbine Oil

STANDARD OIL COMPANY (INDIANA) STANDARD

In any typical power plant installation, the *difference in cost* between the best possible combustion control system and a "second best" system is less than the cost of the fuel burned in one week.

The *difference in performance*, though it may be as little as ½ of 1% of fuel consumption, means a fuel saving *every year of operation* of two to four times as much as the difference in cost.

Here is how it works out in three typical power plants, assuming 6,000 hours of operation per year and a life of 20 years—which is considerably less than the useful life of the average boiler, and using current average fuel prices—which are not likely to decrease within the foreseeable future.

IN COMBUSTION CONTROL SYSTEMS

anything less than the best

Plant Cost	$1,600,000
Boiler Capacity—100,000 lb/hr steam	
Estimated cost of simplified control system	20,000
Estimated cost of best possible control system	25,000
Fuel cost over a 20-year period, minimum	4,800,000
Fuel cost over a 20-year period, maximum—not less than	6,000,000

Saving on fuel by using best possible control, estimated at ½ of 1%—from $24,000 to $30,000.

CASE No. 1

The thousands of Hagan Combustion Control Systems, installed in plants of all types and sizes, in all parts of the country, are your assurance that Hagan Control in your plant means maximum efficiency with the minimum maintenance throughout the whole life of the boiler. Our engineers will be glad to provide full information. Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

CASE No. 2

Plant Cost	$ 8,250,000
Boiler Capacity—500,000 lb/hr steam	
Estimated cost of simplified control system	40,000
Estimated cost of best possible control system	55,000
Fuel cost over a 20-year period, minimum	24,000,000
Fuel cost over a 20-year period, maximum—not less than	30,000,000

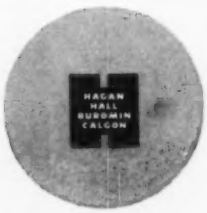
Saving on fuel by using best possible control, estimated at ½ of 1%—from $120,000 to $150,000.

is too expensive-

CASE No. 3

Plant Cost	$ 42,000,000
Boiler Capacity—2,500,000 lb/hr steam	
Estimated cost of simplified control system	45,000
Estimated cost of best possible control system	75,000
Fuel cost over a 20-year period, minimum	120,000,000
Fuel cost over a 20-year period, maximum—not less than	150,000,000

Saving on fuel by using best possible control, estimated at ½ of 1%—from $600,000 to $750,000.



HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THAUSTORQ FORCE MEASURING DEVICES

NOW

Big boiler advantages "wrapped up" in NEW COST-SAVING B&W SHOP-ASSEMBLED UNIT

Here at last is the ideal combination for efficient, low-cost "packaged" steam: the new B&W Integral-Furnace Boiler, Type FM. It combines the many advantages of factory-assembled boilers with the service-proved economies of B&W Integral-Furnace construction. It's delivered fully-equipped for immediate operation.

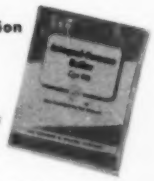
Of prime importance is the fact that this new B&W boiler embodies design, construction, and operating features that have made larger capacity Integral-Furnace units such a heavy favorite among industrial plants and central stations.

Small and medium size plants, institutions, and commercial establishments will find this new unit the ultimate in low-cost heating and process steam-generation from 3,000 to 35,000 lb. per hr. at pressures to 250 psi. Large plants, too, where space and load characteristics warrant, may profitably consider several packaged boilers instead of a single "tailor-made" installation.

Engineered, designed and built under a single responsibility, the new Integral-Furnace Boiler, Type FM, is backed by the same tradition of service satisfaction that has made B&W a by-word in low-cost steam generation for over 80 years.

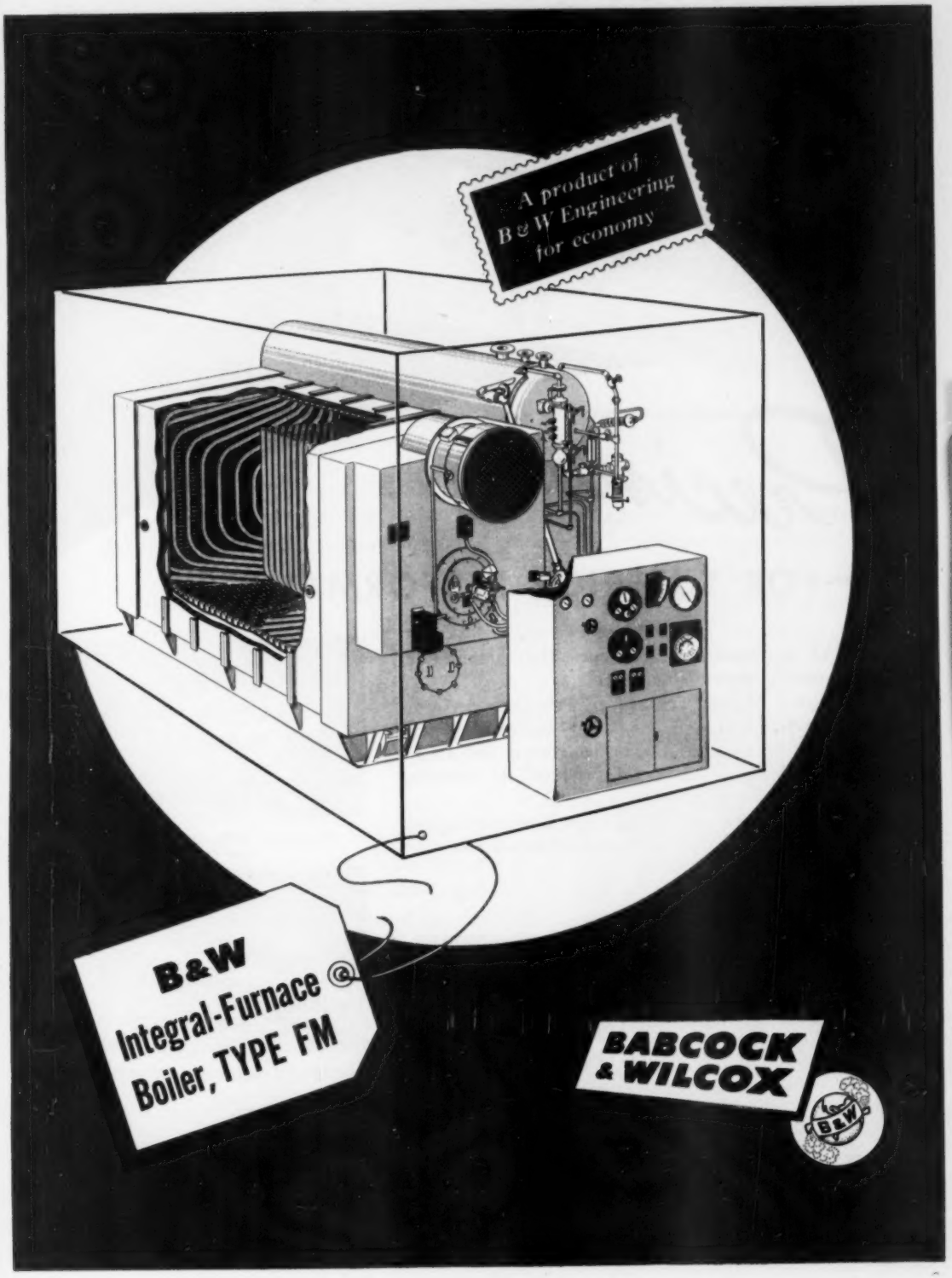
cost-saving features of the new B&W Integral-Furnace Boiler, TYPE FM

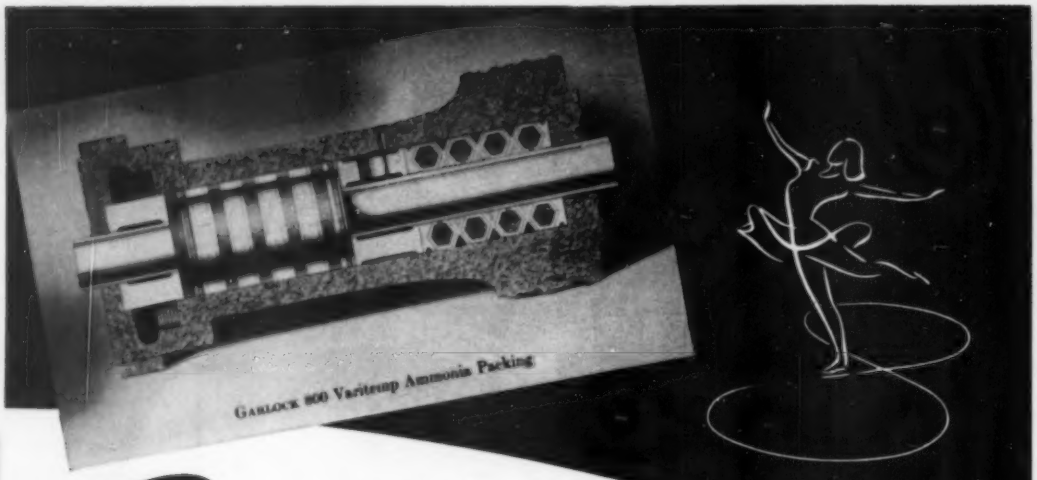
- Saves Erection Time and Cost
- Meets Wide Range of Services
- Handles Quick Load Changes
- Fast Steaming
- Low Maintenance
- Easy Accessibility
- Suitable for Outdoor Service
- Burns Oil and /or Gas
- Saves Fuel
- Saves Space
- Safe, Automatic Operation



Send for Bulletin G-72, detailing the many advantages of this new B&W creation in low-cost steam generation.

The Babcock & Wilcox Company, 85 Liberty Street, New York 6, N. Y.


A product of
B & W Engineering
for economy
B&W
Integral-Furnace
Boiler, TYPE FM
BABCOCK
& WILCOX
B&W



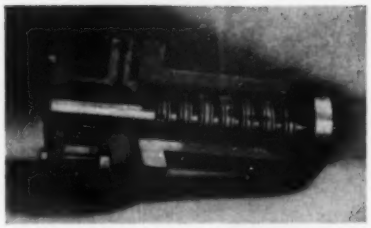
Precision

—FOR SUPERIOR PERFORMANCE

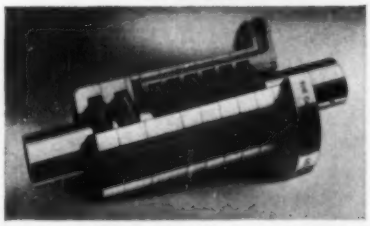
STAR performers excel because they are precise, accurate, dependable.

GARLOCK Metal Packings give superior performance for the same reasons. They are carefully designed by experienced Garlock engineers and accurately machined from metal produced to exacting Garlock specifications.

You can depend on Garlock know-how and Garlock quality controlled precision manufacture—for superior metal packing performance.



GARLOCK 835 Refrigeration Compressor Metal Packing



GARLOCK 875 Gas Compressor Metal Packing

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

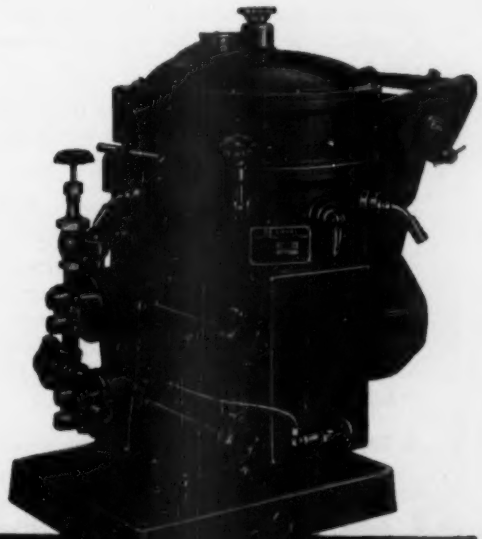
GARLOCK METAL PACKINGS

I STOP TROUBLE before it STARTS!

"I am De Laval Centrifugal Force. I am expert at removing dirt and water from lubricating oil — either turbine lube or Diesel lube. And because dirt and water are the chief causes of lubricating oil deterioration, I actually guard your power plant against trouble. I stop trouble where it counts — ***before*** it happens."

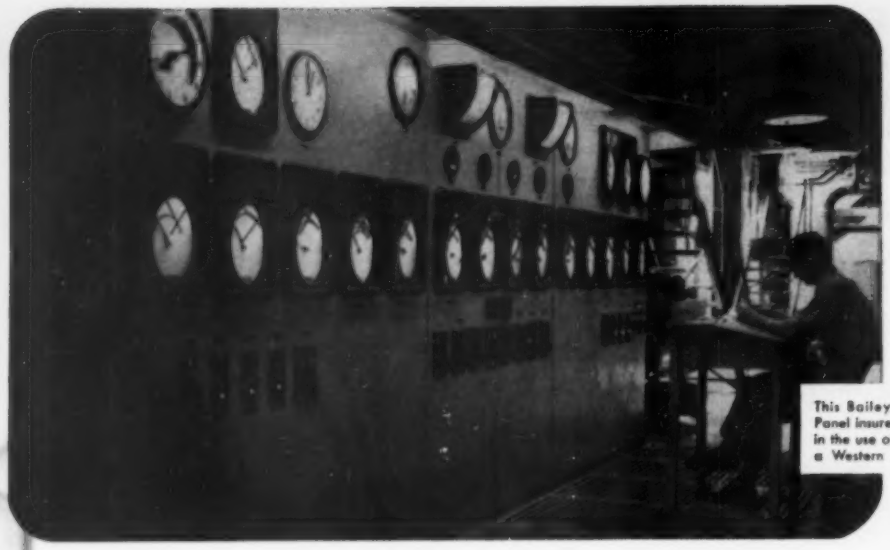
De Laval Centrifugal Force does its job thoroughly. The water is continuously discharged after being removed from the oil by centrifugal force, and the dirt is stored in the bowl, outside the zone where purification takes place.

De Laval Oil Purifiers offer still another advantage to plant operators — these machines have enough reserve capacity to take care of a sudden emergency, such as a surge of water due to a leak.



THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 — 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

De Laval



This Bailey Boiler Control Panel insures high efficiency in the use of Fuel-Dollars at a Western Chemical Plant.

What's Your Fuel-dollar Efficiency?

A dollar's worth of fuel has the *same potential* energy, no matter who's boiler it fires. But how much of the energy actually gets converted to a usable form depends on how you operate your boiler.

That's where Bailey Controls can help. And, here's why, we believe, you'll get better fuel-dollar efficiency with Bailey:

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service—conveniently located near you.** Bailey Meter Company's Sales-Service Engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better fuel-dollar efficiency—for more power per fuel-dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

A-109-1

BAILEY METERS

BAILEY METER COMPANY

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants

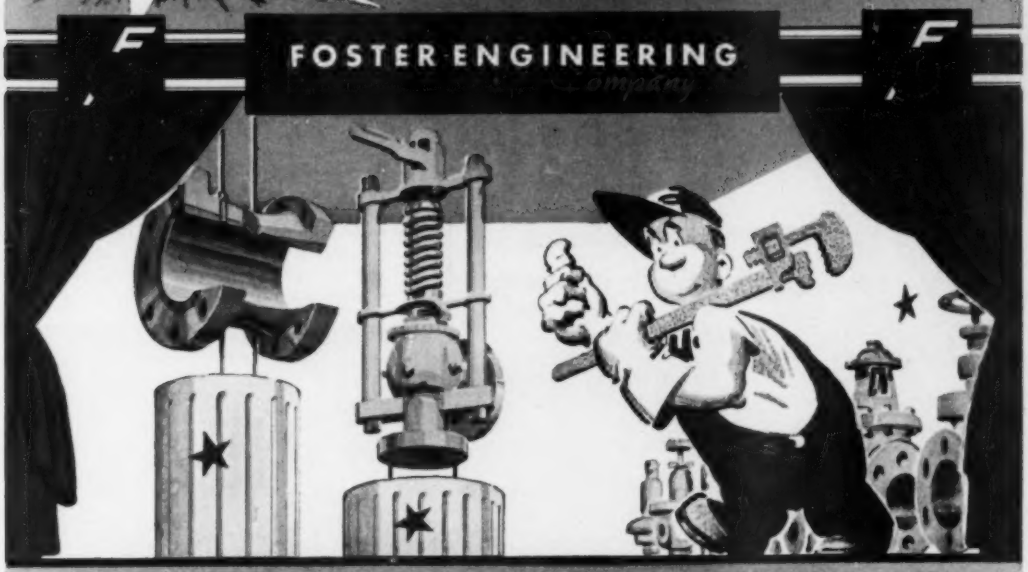
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS

STAR PERFORMERS

at the 19th National

POWER SHOW

Grand Central Palace, N. Y., Nov. 27-Dec. 2—Booths 38-39



★ FOSTER FLOW TUBE
(Gastle Patents)

The revolutionary differential producer for metering flow of liquids and wet or dry gases:

- **Compact . . .** short spool piece
- **Easy to Install . . .** like a fitting
- **Reversible . . .** reads flow in either direction
- **Low Head Loss . . .** low main-to-throat ratio
- **Accurate . . .** equal or superior to conventional primary elements in accuracy

★ FOSTER 38-5V

The revolutionary safety valve that has shattered all performance records. Guaranteed advantages:

- Tight Seating
- Consistently Accurate Popping
- Minimum Blow-Down (can be held to as little as 1%)
- Highest Relief Capacity for a nominal valve size
- Extremely Low Maintenance

★ FOSTER AUTOMATIC VALVES

The complete Foster line has always been noted for HIGH Reliability and low Maintenance.

• • •

Make a note right now to see the Foster line in Booths 38 and 39, it will pay you. And if, for any reason, you can't get to the Power Show do the next best thing—drop us a line, and we'll send you a set of illustrated bulletins, many of which will be available for the first time at the show.

FOSTER ENGINEERING Company

PRESSURE REGULATORS . . . RELIEF AND BACK PRESSURE VALVES . . . CUSHION CHECK VALVES . . . ALTITUDE VALVES . . . FAN ENGINE REGULATORS . . . PUMP GOVERNORS . . . TEMPERATURE REGULATORS . . . FLOAT AND LEVER BALANCED VALVES . . . NON-RETURN VALVES . . . VACUUM REGULATORS OR BREAKERS . . . STRAINERS . . . SIRENS SAFETY VALVES FLOW TUBES

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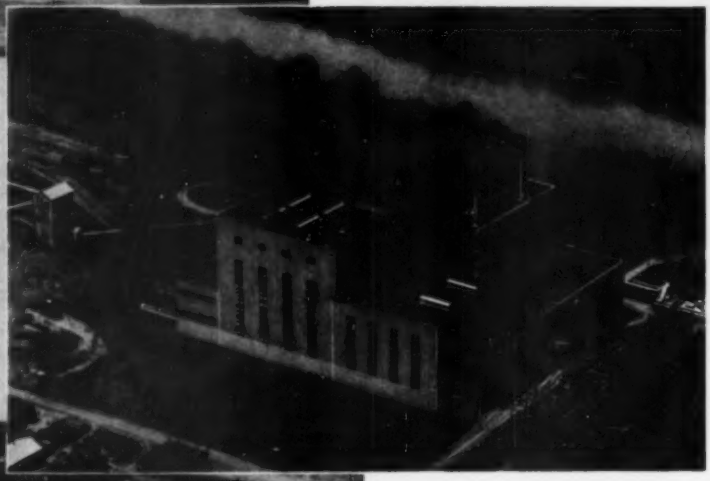
WITH THE NEED CAME THE POWER

Virginia Electric and Power Company instituted an expansion program in 1944 to more than double their electric generating capacity. These new power stations and extensions, three of which are illustrated here, are outstanding examples of efficient design for consistently reliable year-in, year-out, high-capacity performance. Facilities for this program, completed and in process of completion, will produce a total of approximately one-half million kilowatts. Design and construction are by Stone & Webster Engineering Corporation.



1. *Chesterfield Power Station, first with an installed rated capacity of 50,000 kw, has been extended with an additional installed rated capacity of 60,000 kw.*
2. *Recently completed Bremo Power Station extension, 60,000 kw rated capacity.*
3. *Possum Point Power Station where an extension of 60,000 kw rated capacity is under construction.*

VEPCo

STONE & WEBSTER ENGINEERING CORPORATION

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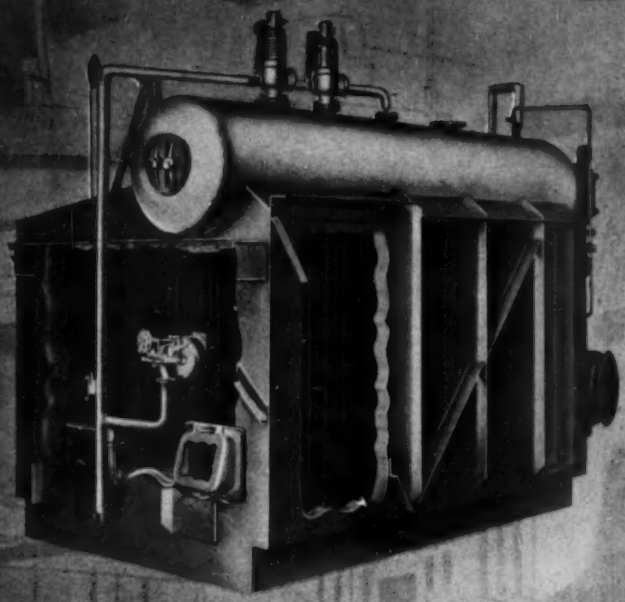
"Package" with a "Pedigree"

Foster Wheeler—first in the design and fabrication of Water-tube Package Steam Generators



Units up to 30,000 lb per hr for both small and medium size plants

Foster Wheeler was building portable Water-tube Package Steam Generators as far back as 1940. Today, mounting orders from leading industries throughout the country testify to the fact that Foster Wheeler Package Steam Generators are "doing the job." These versatile units, which assure higher efficiency and real economy in the cost of steam production, reflect the broad background of Foster Wheeler industrial and central station experience. They are easily installed by means of a few service connections and are adaptable to various fuel and firing arrangements.

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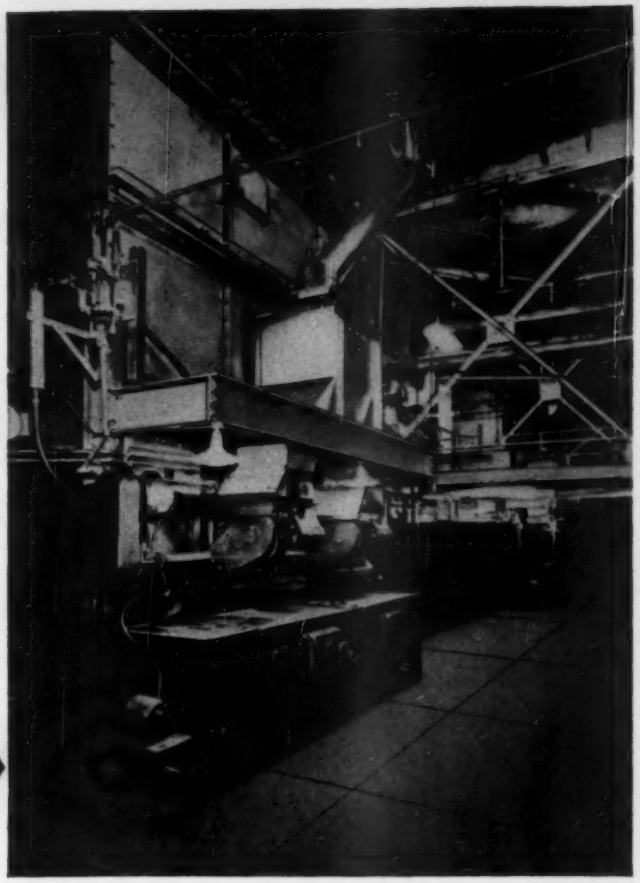
AND AMERICAN PERFECT SPREAD STOKERS GIVE YOU BOTH



Two AE Perfect Spread Stokers recently installed by Marion Power Shovel Company. The boilers, each of 38,000 lbs. per capacity, are Wickes two-drum bent-tube type. Consulting Engineer, Frederick L. Smith. Send coupon for the complete story of this power plant.

SERVICE RECORDS prove that spreader stokers save money wherever installed. They burn almost any coal with remarkable efficiency, including the high moisture, high ash types.

And the AE Perfect Spread Stoker is the best investment you can make in a spreader. Its feeder assures continuous, accurate coal feed, even when coal is wet. Its spiral overthrow rotor *is unique and absolutely superior in distributing coal evenly over the entire grate.* Then, too, the AE engineered cinder reinjection and adjustable overfire air system play important parts in assuring maximum combustion efficiency.

Perfect Spread Stokers come with either continuous discharge, dumping or stationary grates. Capacities range from 8,000 to 500,000 lbs. of steam per hour. Mail coupon for Perfect Spread booklet and the Marion Power Shovel story.

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HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

WATER CONDITIONING

101 For Better Boiler Feedwater—Eight-pp Bulletin W-213-37 illustrates and explains company's Set-Z system of boiler water conditioning, discussing the advantages and applications of this combined hot process and zeolite method. Worthington Pump and Machinery Corp.

102 Water Conditioning Manual—Three enemies of profit control—scale, corrosion, and algae—and how they can be controlled are discussed in this 12-pp booklet, "Water Patrol for Profit Control." Illustrated in full color and presented in a non-technical manner, this booklet shows the reasons for the development of scale in water lines and boilers, tells how corrosion is aggravated and attacks costly equipment, and explains how algae and bacteria develop and damage cooling towers and other water-using equipment. Aquatrol, Inc.

103 Water Treatment Guidebook—Twelve-pp Bulletin 231 covers the complete scope of water treatment for every need—explaining why various water troubles occur and how they can be eliminated. Tells what types of treatment are required to prevent scale formation, corrosion, foaming and embrittlement in boilers; corrosion in steam and condensate lines, turbines and auxiliaries; scale formation and corrosion in feedwater heaters, hot and cold water lines, cooling systems and washing equipment; carbonate deposits in filter bed; algae growth and red water. Also covers supplementary treatments for lime-soda softened, zeolite softened, deionized water. Elgin Softener Corp.

104 Operation by Poppet Valve—Eight-pp Bulletin V-11 features a poppet type multiport valve for manual, semi-automatic or fully automatic operation of company's water softeners or water filters. Explains operation of the valves and how they contribute to efficiency of equipment on which they're used. Photos illustrate valves, softening plants. Also described and pictured are electric control panels for automatic and semi-automatic softeners. Hungerford & Terry, Inc.

VALVES

105 Speed Control Valves—Bulletin 253, 4 pp, presents a line of speed control valves available with or without micrometer graduations and suitable for air, water, or oil control for pressures to 250 psi and temperatures to 250 F. Illustrations include cutaway sketches showing controlled flow from cylinder and free flow to cylinder and actual-size photos of the valves. Specifications given. Ranco Engineering Works.

106 Solenoid Valve Handbook—Catalog 23, 72 pp, describing an extensive line of solenoid operated valves for automatically controlling the flow of liquids and gases, is illustrated and documented with engineering tables. Opening sections are devoted to general information, selection tables and terms and flow charts. Other sections cover safety shut-off and manually reset valves, packless and packed solenoid valves of full pipe area, packless small sized types, three-way types, two- and three-way pilot controlled valves, four-way valves and filters and strainers. Prices on all standard valves are given. Automatic Switch Co.

107 Corrosion Resistant Valves—Technical Information Bulletin 3, 4 pp, introduces a line of small alloy steel valves with molded Teflon seats, outside stem threads and union bonnet construction. Stresses corrosion resistance, toughness and other merits of the use of Teflon in these valves, and illustrates needle, plug gate and sampling valve types available. Includes dimensions. Alloy Steel Products Co., Inc.

108 Diaphragm Control Valves—Illustrated Bulletin 310, 4 pp, gives construction and operating information on diaphragm control valves made of stainless steel and affording the easy accessibility and other advantages of the open yoke design—formerly not available in stainless. Dimensions included. Kieley & Mueller.

109 Spray Valve—Bulletin 69 explains and illustrates the design and operation of a new valve which offers a simple and inexpensive system for accurately controlled spraying of lubricants onto open gearing, slide surfaces and other open bearing areas. Sketches show how the valve works; photos show some installations. The Farval Corp.

ELECTRICAL

110 Up-to-Date Power Equipment—Bulletin 2326B1800, 32 pp, briefly presenting products commonly used on power generating, transmission and distribution systems, covers generation, distribution and control equipment. Included under generation are steam and hydraulic turbines, generators and such auxiliary equipment as condensers, pumps and water conditioning. The distribution classification includes transformers, voltage regulators, unit substations and circuit breakers. Miscellaneous motor control, switchgear and voltage regulation equipment are also covered. Allis-Chalmers Mfg. Co.

111 Overload Protection—Four-pp illustrated Instrumentation Data Sheet 9.1-3 titled, "Continuous Record of Electrical Power Increases Central Station Efficiency," describes methods for accurate and rapid measurement of useful power with a check on reactive power to prevent overloading of generators. Tells how by using certain thermal converters and auto-transformers with company's electronic instrument the system provides a continuous record of the power output of individual generators, the station and the system total. Industrial Div., Minneapolis-Honeywell Regulator Co.

112 For Ordering Electronic Equipment—Catalog 124 is company's just-released 1951 ordering book covering radio, television and electronic equipment. Emphasis is placed on equipment for industrial maintenance, research and production requirements. There are detailed listings of standard and special application electronic tubes, test instruments, voltage stabilizers, transformers, relays, switches,

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rectifiers, wire and cable, batteries, generators and related equipment. Other sections cover portable Geiger counters, public address systems, technical books. Allied Radio Corp.

113 **Heavy Duty Connectors**—Twelve-pp Bulletin MD-1953 is illustrated with application photos, dimensional drawings, data and material listings of company's 14 series of electric connectors. The series includes fittings rated at 125 v d-c and 600 v a-c and is used primarily for heavy duty and power circuits, with contacts rated at 30 amp. Cannon Electric Development Co., Div., Cannon Mfg. Corp.

114 **Synchronous Condensers and How to Use Them**—A description of manufacturer's synchronous condensers, the proper use of which results in greater system efficiency and savings in power costs, is contained in 16-pp Bulletin 0197283. Covers air-cooled, outdoor air-cooled, and hydrogen-cooled condensers built to meet applicable NEMA, ASA and AIEE standards. Standard features of these units are given together with a description of the starting and mechanical construction details. Exciters, starting autotransformers and starting motors are also discussed. Allis-Chalmers Mfg. Co.

115 **Insulation Breakdown Testers**—Bulletin 5A, 4 pp, illustrates and describes 12 models of high-potential insulation breakdown testers. Mobile and semi-portable types included have capacities from 500 va to 10 kva, with test voltages from 1000 to 30,000 v a-c. Uses include insulation breakdown testing on motors, generators, insulated power lines, and other testing applications. Associated Research, Inc.

FIRE SAFETY

116 **Air Foam for Fire Fighting**—This 24-pp booklet on air foam or mechanical foam is generously illustrated with photos and diagrams and contains information on this method of fire fighting. Describes air foam, methods of application, high and low expansion types of foam compounds, specifications and operating characteristics for five sizes of portable pressure, mobile and accessory foam proportioning tanks and connections of several types. Pyrene Mfg. Co.

117 **Properties of Flammable Liquids**—Here is a new edition of "Properties of Flammable Liquids, Gases and Solids," described as one of industry's most authoritative reference booklets. An excellent source book on fire prevention, its key feature is a table of more than 650 flammable materials found in industrial plants, giving for each the chemical formula, flash point, explosive limits, auto-ignition temperature, specific gravity and other data. This latest edition lists more than 200 materials not previously covered. Engineering Div., Associated Factory Mutual Fire Insurance Companies.

INSTRUMENTS AND CONTROLS

118 **Improved Hand Tachometer**—The advantages of a tachometer, which shows at a glance machine speeds, speed variations and belt slippage, are stressed in this 4-pp illustrated bulletin. Discusses design, accuracy; includes specifications. O. Ecrnickow Co.

119 **Handbook on Regulators**—Filled with useful information on pilot-operated pressure and temperature regulators, Catalog 250, 28 pp, is illustrated with photos, charts and tables. Discusses main valves, controls and strainers, gives capacity and flow data, also dimensions and weights. Case examples problems are cited to help users select the correct type and size regulator. Special sections of the booklet treat thermometers, desuperheaters, electrically-controlled regulators, strainers and flange standards. Spence Engineering Co., Inc.

120 **Insulation Resistance Testers**—How insulation resistance testing can be a "just button job" is told in 4-pp Bulletin 3-A. Stresses speed, accuracy and other merits of company's meters; gives specifications, pictures several models. Associated Research, Inc.

121 **As Easy As Signing Your Name**—That's what this 2-pp illustrated bulletin says about using the Oscillotracer, an inexpensive instrument designed to "convert an oscillograph into an oscilloscope." Tells how the instrument sets up a repetitive pattern accurately on paper or in your notebook, giving you a permanent record of a cathode-ray oscillogram. Specifications, prices given. Robert A. Waters, Inc.

122 **Industrial Temperature Control**—This 24-pp two-color booklet sets down the basic principles of industrial temperature control through mercury bulb instrumentation. Defines types of control systems and distinguishes between them. Describes eight ways of responding to temperature, five ways of putting that response to work, and nine of company's basic instrument types. Discusses the influence of the firing system on the design of control system. Fundamental tenets of mercury bulb installation, and basic concepts of electrical and mechanical control theory. Typical circuits and piping arrangements, and ranges and calibrations of scales and dials are dealt with diagrammatically. The Partlow Corp.

123 **Air Locks**—Bulletin S-31, 3 pp, describing company's air locks and trip master controls for holding regulating and control valves in position during failure of air supply, is illustrated with photos, diagrams and line drawings. Fully describes operation of the locks and control and lists their applications for various types of equipment. The Swartwout Co.

124 **To Avoid Broken Crankshafts**—A crankshaft alignment indicator applicable to gasoline, dual-fuel and diesel engines is described and pictured in this single-sheet bulletin. Includes specifications, price. Beakman Industries, Inc.

125 **Chemical Feeders**—Twelve-pp Bulletin 30-C14 presents three sizes, covering a feeding range from 1 to 5,000 lb per hr, of feeders designed to handle practically all types of dry chemicals or materials used in the treatment of water and in many process industries. Includes a discussion of such features as accuracy, wide range, dumpproof operation. Diagrams show how automatic proportional control may be obtained. Typical arrangements and installations are given and photos of equipment included. Also provided are data on computing dissolving chamber capacities, typical specifications, and dimensional data. Omega Machine Co.

PUMPS

126 **Close-Coupled Pump**—Design and construction features of a close-coupled pump and motor—the Electrifugal—are described in illustrated Bulletin [illegible]468, 6 pp. This pump has a single shaft mounted in a unit cast frame to assure permanent alignment, and is available in ratings from 10 to 300 gpm at heads to 220 ft, and motors are rated from ½ to 10 hp. Available styles are pictured. Allis-Chalmers Mfg. Co.

127 **Simplified Maintenance Pump**—Bulletin 1081 contains a full description, cross section drawings, capacities, rating tables and dimensions of company's Type C6 pump. This pump is designed to fit a factory service and exchange plan—all parts except here pump casing are contained in an easily replaced rotor assembly. Advantages of the pump are explained and illustrated. DeLaval Steam Turbine Co.

128 **Handy Guide to Pump Selection**—Economical centrifugal pumping units for a wide range of industrial appli-

(Continued on page 140)

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Foster Wheeler Dual Circulation Steam Generators

The first of a group of Foster Wheeler Dual Circulation Steam Generators was placed in service in May 1948 at a large midwestern refinery. It has been in successful operation ever since and has proved its ability to produce steam of much greater purity than has been hitherto attainable in a boiler of conventional circulation.

Evidence of the increasing acceptance of the Foster Wheeler Dual Circulation Steam Generator is demonstrated by recent additional orders from both the utility and refinery industries.

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, N.Y.

Write for a copy of Bulletin S-80-1 which covers the principles and advantages of Dual Circulation

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MOTORS

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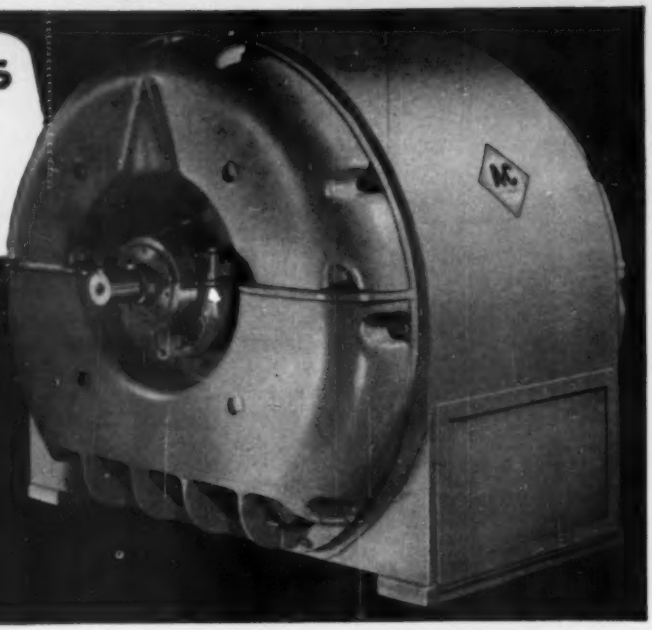

Built to Cut Maintenance

EASIER MAINTENANCE PROCEDURES and lower maintenance costs are important features of this brand new line of large motors. One man can perform all routine maintenance procedures, including opening up the motor for cleaning. Bearing surfaces are not exposed to abrasive grit and dirt during cleaning operations.

The appearance of this new line of large motors reflects the advanced design and fine workmanship that goes into their manufacture.

A well-braced, sturdy fabricated steel frame with cast-iron end brackets rigidly support and protect working parts. Ventilating openings are large to provide adequate cooling air at low velocities with resultant low sound level.

Wide Range of Sizes

These new design Allis-Chalmers drip-proof and splash-proof squirrel-cage induction motors are built in sizes from 60 hp at 300 rpm to 1500 hp at 1800 rpm. Ask your Allis-Chalmers representative to show you the details of this exceptional new motor or write for Bulletin 05R7542.

How's This for Accessibility

One man can remove the end brackets and air baffles and reach right inside motor with his vacuum cleaner or air hose. Bearing remains sealed against abrasive dirt throughout the cleaning operation.

Large air discharge openings with removable louvers allow plenty of room to get in with an electric drill for doweling and bolting the motor to the base. Plenty of room to reach up back of the stator core for cleaning.

A-3179

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Puzzle for experts

There is no need for "cutting and trying" on the job to make a prefabricated piping sub-assembly fit perfectly. Prefabricated miles away to exact dimensions and specifications these pieces of piping are links in piping systems which may carry steam up to 2500 p.s.i. and 1050°F.

Grinnell integrates the many factors in this complex, highly technical assignment in one organization of specialists. Major economies result from this single responsibility which includes interpretative engineering, metallurgical research, compliance with code requirements, manufacturing drawings and specifications, production schedules, purchase of materials, specialized facilities, skilled personnel, control of quality and rigid inspection.

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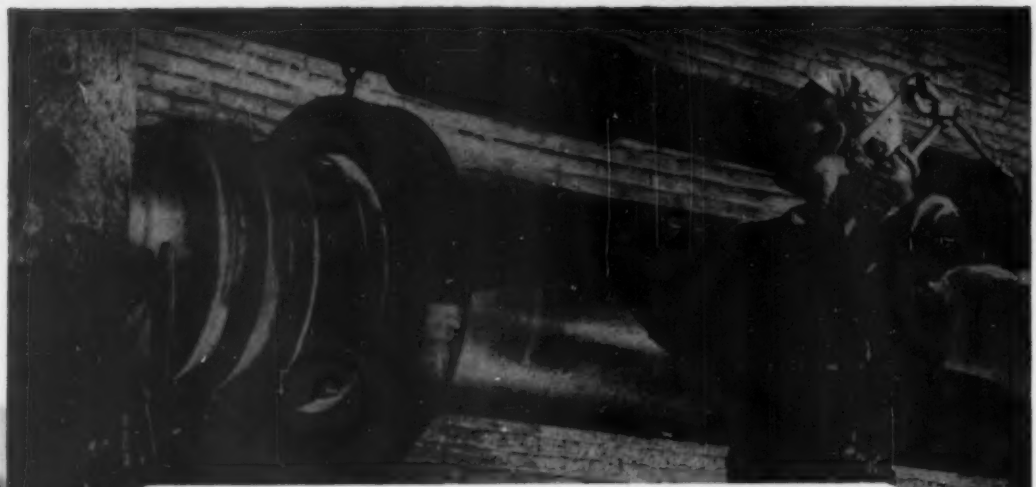

Special Machine makes first 30" O.D. Corrugated Alloy Piping . . .

The first 30-inch O.D. chrome-moly corrugated piping was recently formed on the unique device shown here. Totaling some 90 feet over-all, eight pieces comprise the complete order. They are for the major part of the exhaust-steam line from a topping turbine in a main power station of a metropolitan utility in the East.

Beyond physical size itself, the major problem in fabrication was to preclude cracking, a defect much more apt to occur in forming chrome-moly than in working either carbon or carbon-moly steels. Through carefully controlled incremental heating and subsequent compression on a specially built machine, the corrugations were formed, giving the final corrugated piping five times the flexibility of plain piping.

Specific know-how in incremental heating was to a large degree responsible for the success of this operation . . . this and an extensive background in the fabrication of alloys. Over the years special alloy fabricating methods have been developed by Kellogg engineers, who have been entrusted with such recent innovations in power piping at the first HT-HP stainless steel installation and the fabrication of piping for the original 1050°F. station.

Knowledge of such special techniques is among the advantages utility companies gain when they specify M. W. Kellogg HT-HP power piping.

M. W. KELLOGG

Special studies of unusual problems such as graphitization to assure long life and low maintenance.

Metallurgical research by recognized specialists who have made major contributions in this field.

Exclusive Equipment for accurately analyzing stresses in piping and providing unique data for critical installations.

Complete facilities for the fabrication of steel products from simple forgings to specialty cast bi-metallic devices.

Top welding performance in shops and in the field by welders accustomed to working under X-Ray checks.

Quality control, devised by metallurgical experts, embracing forming, heat treating and non-destructive testing.

Vessels
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Radial Brick Chimneys

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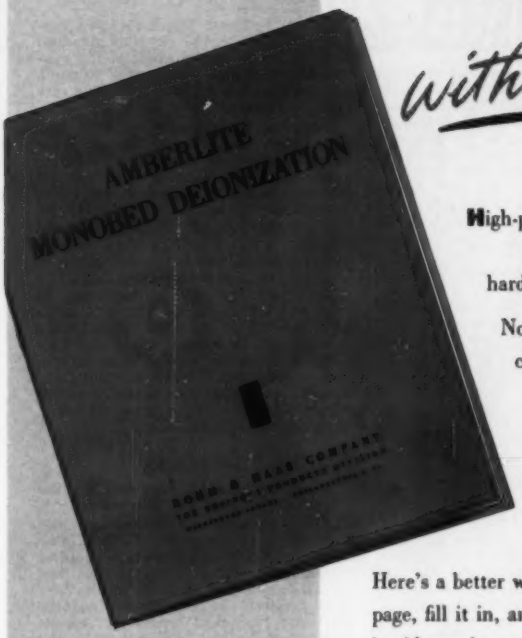
ZERO TOTAL IONIZED SOLIDS

without Evaporation!



High-pressure-boiler feedwater—passed *once* through a *single* bed of AMBERLITE ion exchange resins—is free of silica, hardness, carbon dioxide . . . of essentially all ionized solids.

No fuel is consumed, no heat is lost, no shutdowns for cleaning are needed. The cost of equipment—and of its operation—is low. The treated water contains less than one-tenth of one part of ionized solids per million parts of water—no matter how poor the quality of your raw water supply. And alkalinity is . . .

But we're getting ahead of our story.

Here's a better way to tell it. First, clip the coupon at the bottom of this page, fill it in, and mail it to us. When you've had a chance to read the booklet, ask your consulting engineer or manufacturer of water conditioning equipment how AMBERLITE Monobed deionization can insure the life and efficiency of your high-pressure boilers. Or, if deionization in *one* ion exchange unit doesn't quite suit your special needs, ask him how high quality water can be produced by various combinations of AMBERLITE cation and anion exchange resins, operating in *separate* units.

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PEI-11

NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card pages 35-36.

1—SHOP-ASSEMBLED BOILER

For unit shipment, is ready to place, hook up and operate

Developed to reduce the cost and time of installation, the Type FM Integral-Furnace Boiler is designed for small and large industrial and processing plants, commercial buildings, schools, hospitals, laundries, dairies. Even larger plants having few skilled boiler operators may find it advantageous to use several of these shop-assembled units, company points out.

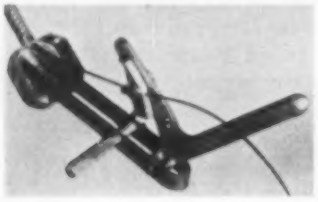
The new unit comes in standard sizes for loads from 7,000 to 25,000 lb of steam per hr, at pressures to 250 psi. It is a water-tube boiler with a completely water-cooled furnace. It can be set on a concrete floor or concrete corner blocks, and moved from one location to another, if required. Installation connections are limited to fuel, electricity, water, steam and stack.

The boiler has push-button start and stop and automatic controls for handling load variations. It's described as a "fast steamer" capable of coming on the line quickly and readily handling sudden load changes. Firing may be by oil, gas or combination oil and gas, and fuel changeover is easily made. This boiler can also be used outdoors. The Babcock & Wilcox Co.

2—FISHTAPE PULLER

Is combination tool for hand or pressurized pulling jobs

Combining the conventional hand puller with a detachable pressurized puller for difficult jobs, the Little Giant pulls from top, sides and bottom and can be adjusted to pull at any angle with any length of stroke. The controlled automatic gripping and releasing action during operation is intended to keep the fishtape from kinking or



snapping out. Sawtooth holding edge fits standard outlet boxes, gutters and switches up to 8 in. The puller has a reversible hand grip for either left or right hand operation. Mallasch-Brandt Engineering Co.

3—SILVER PLATING POWDER

For on-the-job plating of high amperage electrical connections

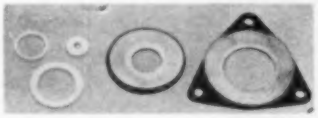
Cool-Amp, developed for improving continuity of electrical service and reducing maintenance time, offers a quick solution to the problem of heating due to oxidation. It is pointed out that even on connections where overheating is not apparent, this plating powder can prevent losses too small to create noticeable heat but big enough to accumulate into a real power loss.

The powder deposits a coat of silver that won't peel off and will provide cool maximum conductivity for copper, brass, or bronze contacts, company states, and is harmless to the user and easily applied. The only equipment needed is a sharp steel wire brush or abrasive cloth, clean rag and water. Coverage is 6000 sq in. to the pound and a 1 lb bottle costs $11.50. Cool-Amp Co.

4—TEFLON GASKETS

Offer high heat resistance, also toughness and durability

For industrial uses this manufacturer fabricates Teflon in both solid and jacketed gaskets. The Korda-Clad, a Teflon-jacketed gasket now available, incorporates a seamless, one-piece machined jacket of Teflon to assure a



perfect seal and a heavier wall of Teflon on the inside diameter of the gasket to give added strength at the point of strain. It comes in hard, medium and soft grades, suitable for metal and nonmetallic flanges, and in sizes from ½ to 6 in. ID for ASA or special flanges. Chicago Gasket Co.

5—GEARSHIFT DRIVE

Incorporates both primary and secondary gear reductions

The Type R3AC gearshift is designed to individually motorize and drive machinery requiring low range of selective operating speeds, combined with high radial load capacity. The drive is a compact combination of a 5 hp, 1200 rpm integrally mounted electric motor and a four-speed sliding gear transmission having selective primary gear ratios of 4.15, 3.15, 1.85 and 1.00 to 1, and a secondary gear train with 11 optional ratios from 2.25 to 1 to 1.00 to 1, providing a choice of output speed combinations from 123 rpm to 1140 rpm.

Over-all dimensions including standard 5 in. output shaft extension are 31-11/16 in. long, 12¼ in. high and 18¼ in. wide. Drive operates on polyphase a-c power supplies of standard frequencies and voltages below 600. The Lima Electric Motor Co.

6—POLE TYPE TRANSFORMERS

Are finished with longer-lasting three-coat mica-base paint system

The life of the finish on these pole-type distribution transformers has been more than doubled by a three-coat paint system, according to company. Called the "Coastal Finish," each of the three coats functions cooperatively with the others to withstand the oxygen, acids, salts and alkalis found in seacoast and industrial atmospheres. The three-coat system is baked on the same as standard finishes, but a modification of the system air dries, and can be used to patch a transformer in the field should its surface be damaged.

Each coat has a special function. The prime coat—applied after the metal has been cleaned and treated with phosphate solutions—contains zinc chromate and iron oxides to provide a coat that's flexible for thermal expansion and contraction and resistance to salts, acids and alkalis.

The intermediate coat, mica flakes in a vehicle of modified phenolic and alkyd resins, provides further resistance to heat and chemicals and acts as a shingled roof effect to ward off moisture and oxygen. It also enhances the heat stability of the paint. The third or final coat screens out ultraviolet light from the sun, enhances the resistance of the other two coats to corrosive elements. Westinghouse Electric Corp.

7—FLOW CONTROLLER

Is designed for high accuracy and fast response, low maintenance

In this automatic controller, flow rate is measured by company's Magna Clutch Flow Meter which utilizes a frictionless magnetic coupling between the float and the pen and control mechanism. High accuracy is credited to the large float and long float travel and to the frictionless design. To this is added the sensitive pneumatic controller equipped with adjustable automatic reset and proportional band ajustable from 0 to 175 per cent. There is no stuffing box, and O-ring manometer seals are used. The manometer is accessible without disconnecting pressure piping and the float, which is removable, is the only moving part. Penn Industrial Instrument Corp.

8—HYDRAULIC MOTOR VALVE

Is ruggedly-built electro-hydraulic type for open-and-shut control

The Sarcostat is designed for automatic operation by thermostats, pressurstats, liquid level or flow controls. As a shut-off valve in an inaccessible location it can also be actuated by push button. It handles steam, water, oil, gas or air, and is suitable for remote control, by hand or thermostat, on steam or water branch mains for space heating systems. Gradual opening action is provided to protect piping, quick closing to prevent overheating.

The valve operator, actuated by hydraulic power, operates single seated valves up to 1½ in. or double-seated valves to 4 in. at 125 psi. When full thrust is used, standard valves will open in 60 sec and close in 10 sec. They're available with adjustable stop for partial throttling. Bodies — available in single-seated, needle, piston or double-seated types — are brass or iron with union or flanged connections. Two wire

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normally closed for connection to 100 v a-c, 60 cycle current. Sarco Co., Inc.

9—SINGLE STRAP CLAMP

Simplifies making lateral pipe connections to branch and main lines

This clamp utilizes taper sealing—the use of shaped molded rubber and oil resistant type gaskets—to effect a leak-proof seal. A principal feature is a wedging action of the resilient gasket which develops partly from hydraulic

pressure within the pipe plus moderate tightening of the strap nuts. The taper seal idea was developed for use on asbestos-cement pipes but is now in production for light wall steel pipes. Extra-wide arc saddles are used to avoid extreme pressure commonly used to seat metallic type gaskets. Smith-Blair, Inc.

10—PLASTIC SEALER

For threaded joints, gasketed surfaces; is fast setting, flexible

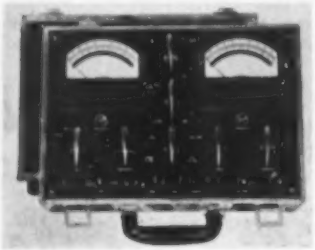
Leak Lock sets much faster than many plastic-type sealing compounds, according to manufacturer, and this quick setting feature keeps liquids and gases from pushing through the compound before it has set. It forms a tough, rubbery film that flexes with vibrations and stays plastic enough to permit easy disassembly.

Because of the high resistance of its poly-hydroxylated plastic base to mechanical stress and chemical breakdown, Leak Lock is applicable for use with a wide range of chemicals and solvents. Its dielectric properties enable it to be used as both sealer and insulator. Available in tubes and cans. Highside Chemicals Co.

11—COMBINATION METER

For electrolysis, corrosion and cathodic-protection testing

The new Model B-3 Multi-Combination Meter is small, compact, and low priced as compared to company's previous Model M, although it has a low range of 2 mv and mirror scales 3.9 in. long. Accuracy is given as 1 per cent.



With this meter practically all measurements encountered in electrolysis, and corrosion investigations and cathodic-protection testing can be made. By use of a selector switch, the two high-sensitivity d-c instruments can be connected into a variety of measuring circuits for measurement of potentials, current, resistance and soil resistivity. Internal batteries can be used to supply and control current for test purposes. Voltmeters or voltmeter and ammeter can be used separately or simultaneously. Polarity reversing switches are provided for both current and potential measurements. Instrument is mounted in a case, weighs 13 lb. M. C. Miller.

12—FORGED STEEL TRAPS

Are built for high-pressure, superheated steam service

These inexpensive, small traps are suitable for steam pressures to 500 lb and total temperatures of 800 F, and have ½ or ¾ in. pipe connections. An addition to company's Super-Silvertop line, they're made with head and body of forged steel to withstand shock and explosions. Internal parts are stainless steel and valve and seat are of Anderloy. Traps have recessed gasket to prevent blowing out.

Available in two types, No. 340 is installed straight-in-line or as an elbow, affording quick installation. Type No. 60 has inlet in the bottom and outlet connection in the top for a vertical installation. Both types have guided bucket for positive valve closing. V. D. Anderson Co.

13—ROLLER TAPE

For accurate, one-man measurement vertically, horizontally, around curves

This lightweight unit is reported to permit accurate measurements from inches to almost unlimited lengths by a single individual. Recessed tape face on rim of wheel indicates measurement in fraction of inches up to 2 ft, and an automatic counter clocks measurements in feet and cycles of 100 ft. In operation, an audible click is made for every 2 ft measured and a bell rings at the 100-ft mark. The handle collapses down to 8 in. when not in use. The unit costs $17.50. Rolatape, Inc.

14—DIESEL ENGINES

In 700 to 2080 Bhp capacities with speeds of 257 to 375 rpm

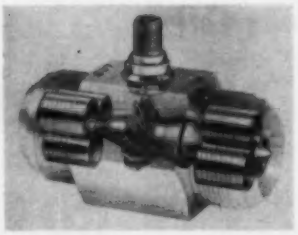
Designated the Series 700, these engines are intended primarily for stationary service such as electric power generator drive, pumping service on oil or gas pipe lines, municipal water pumping service, but they are also suited for diesel-electric main propulsion drive and direct reversing propulsion drive in marine service. The engines are four-cycle, 17-in. bore, 20-in. stroke, and available with six and eight cylinders, normally aspirated or supercharged.

The Series 700 was designed to replace company's Models VM and VG and increase the power range while reducing the size and weight per horsepower. Welded construction of bedplate, frame and cylinder housing is a leading factor in the modernization program. The Baldwin Locomotive Works.

15—ELECTRONIC FLOWMETER

Is designed to handle difficult problems of flow measurement

This instrument is described as especially suited for measurement problems involving high capacity, corrosive liquids, acids, gases and liquid oxygen.



It comprises a flow sensing unit with a dynamically balanced rotor and magnet rotating within a non-magnetic housing and an external pickup coil connected to an electronic integrator or totalizer or both.

The housing of the sensing unit is usually a standard AN fitting no larger than the line into which it is installed. Fluid passing through the housing turns the rotor at a speed determined by velocity of the liquid and pitch of the rotor blades. A cylindrical Alnico magnet with the rotor sets up a rotating field which generates a-c current in the pickup. Frequency equals rotor speed when magnet is two-pole; a four-pole magnet provides twice the frequency. A single shielded wire conducts a-c current to an electronic unit which either integrates it into d-c current for operating a rate-of-flow meter, or counts and totals the cycles on an electro-mechanical counter of the Veeder-Root type.

According to manufacturer, practically no maintenance is required for the sensing element—its plastic bearings are self-cleaning, corrosion resistant and dimensionally non-critical—and the only limitation to foreign materials in the flow is the size which can pass between rotor blades.

Electrical impulses produced in the sensing unit are conducted to a combination electronic integrator and totalizer housed in a lightweight case. Standard sensing unit sizes range from ¾ to 3½ in. Units up to 1½ in. size have standard male flared tube connectors; larger sizes have flanged fittings. Potter Aeronautical Co.

16—MULTIPLE FEED OILERS

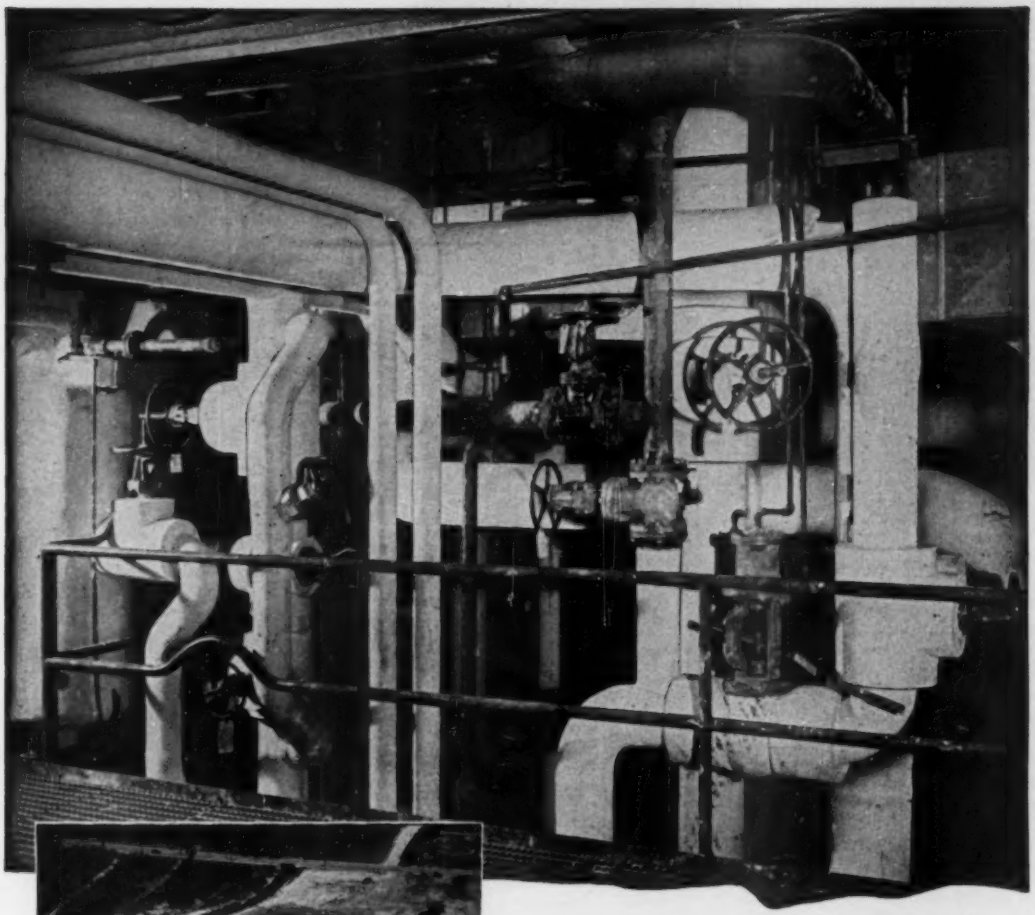
Offer manual or automatic solenoid control of 1 to 20 feed outlets

These oilers deliver a measured quantity of oil to multiple bearing points that require frequent and dependable oiling. They are mounted above the highest point to be lubricated and heavy or light oils are fed by gravity from a large reservoir through individually adjustable needle-valves and through copper or Neoprene tubing to the various bearings. Occasional refilling of the single large reservoir, feed adjustments and operating of starting and stopping the flow of oil are controlled from one central point. Reservoirs are Pyrex or Lucite in pint, quart or 2½ qt capacities. Trico Fuse Mfg. Co.

17—ADJUSTABLE SPEED MOTOR

Has pre-set speed device for achieving a fixed speed

Company's ACA Motor (a-c adjustable speed) is now available with a mechanical follow-up control for achieving a fixed pre-set speed. This new device is designed to enable the predetermined speed to be set manually by a knob either on the motor or at the end of



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a flexible cable 10 or 15 ft away. The speed adjustment can be made while motor is at standstill or running.

In operation, the mechanism actuates a pilot motor which drives rotating brushes around the commutator to a position corresponding to the setting of the speed adjustment knob. A stop or automatic slow-down returns the brushes to the lowest speed position without disturbing the original setting. When the ACA motor is restarted the brushes again come back to the preselected speed. Small and Medium Motor Divs., General Electric Co.

18—RATIO TOTALIZER

For combining control signals or pressure in any desired ratio

With this handy device you can combine two or more control signals or pressures to produce a single output loading pressure. It may be used to add, subtract, multiply or divide control signals in computing circuits or introduce proportional hand action, rate action, or automatic reset, separately or in any combination, in control circuits. Two or more totalizers may be connected pneumatically to secure combined characteristics of rate action, proportional band, automatic reset.

The standard model has four pressure chambers arranged in opposing pairs and acting through non-metallic, flexible diaphragms on the ends of a balance beam. The fulcrum of this beam is adjustable, giving beam arm ratios from 1:1 to 16:1. This corresponds to a proportional band of 25 to 400 per cent when used as a regulator.

Any of the input chambers may be replaced by an attachment to load the balance beam for measurament of a mechanical force; chambers may also be modified by tension springs or metal bellows on loading elements.

Successful use of the totalizer is reported in process control, central station and industrial power plant regulation. The unit is 9½ in. long and pressure centers are 6 in. apart. Maximum adjustment range of fulcrum is 4⅜ in. Hagan Corp.

19—REPAIR KIT

Contains phenolic plastic cloth, plastic metal, and solvents

With the Phenolic Plastic Kit you can repair breaks, dents, holes, scratches in wood, metal, plastic, glass or fabric, according to company, and no heat, flame or special tools are needed. You simply sand the area to be repaired, apply the phenolic plastic cloth, and spray or brush on the plastic metal. This dries quickly and the surface is then ready for any desired finish.

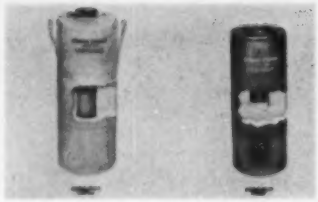
The kit is suggested for quick repairs of roofs, furnaces, plumbing; for stopping leaks in boilers, pipe lines; for tightening loose nuts, screws, handles. Kit costs $5.95. The Pioneer Chemical & Mfg. Co.

20—CARTRIDGE REFILLS

In three types, for handling various oil purification problems

Longer refill life, thorough oil purification and trouble-free performance are claimed for these interchangeable cartridge refills, company's Types MC, MF and S. They're designed to remove either solids or products of oxidation or both.

The MC is a woven cotton bag containing 15 lb of Cranite, processed fullers earth. Oil passes through 2½ in. of Cranite surrounding the center tube in addition to a layer of felt and a 250 mesh monel screen covering the center tube.



The MF is a perforated metal basket lined with woven cotton sock material and packed with Palconia, a cellulose filtering medium. Oil passes through the cotton sock and 2½ in. of cellulose around the center tube in addition to felt center tube cover to remove solids, abrasives and scale.

The low-cost Type S contains 4½ lb of Palconia packed in cotton sock material. Its performance is said to be comparable to that of the Type MF in removal of abrasives and scale. Fiber center tube simplifies disposal of spent cartridge as entire unit is consumed by burning. Honan-Crane Corp.

21—CHECK VALVES

With O-ring seal, are available in sizes ranging from ⅛ to 1 in.

Formerly produced only on a custom basis, Circle Seal Valves are now offered in two models for standard and very low pressure systems; both are poppet type using an O-ring seal. Absolute sealing, and minimum flow resistance for pneumatic and hydraulic systems are among features stressed.

The valves are designed to provide quick opening and positive closing at extremely low pressures. Opening pressures as low as 1 psi differential in standard types and 4 in. water column in the low pressure types are reported, and poppets close at zero flow before return flow starts.

The operating principle utilizes a synthetic O-ring of Buna N between conical surfaces on poppet and valve housing. As line pressure works against outer periphery of the O-ring, increased line pressure increases the sealing pressure. The poppet load is carried by a metal shoulder in the valve housing. In open position, fluid flows around the streamlined poppet to afford good flow characteristics with low pressure drop. The spring retainer, which serves as poppet stop, has ample ports to allow full flow under surge conditions. James-Pond-Clark.

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

ELECTRICAL

201 Power Factor Correction—Examples illustrating basic considerations in the improvement of system power factor are contained in Bulletin 05B7465, 4 pp. It points out economical and operational advantages of improving plant power factor and advisability of keeping the load power factor up to 0.8 lagging or higher, and tells how the effects of low power factor can be inexpensively corrected by the judicious use of synchronous motors or a synchronous condenser. Allis-Chalmers Mfg. Co.

202 Synchronous Motors — High speed synchronous motors are described in 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features of the motors rotor and stator. Mechanical modifications also are illustrated. Elliott Co.

203 Low-Speed Synchronous Motors—Publication GEA-5333, 8 pp, illustrates typical installations of efficient high-power factor, constant-speed drives, describes their construction features, and indicates mechanical modifications and performance data. Covers three-phase and two-phase motors in company's "800" series with frame sizes of 6184 and larger and ratings from 20 to 15,000 hp. Photos show detail of stator and rotor design. General Electric Co.

204 Care of A-C Rotating Equipment—To promote intelligent and consistent maintenance of electrical machines, company has published Bulletin 05R7417, which is a series of articles by Fraser Jeffrey. Contents of the 24-pp booklet cover preventive maintenance and machine repairs, and include such subjects as drying moist insulation, measuring insulation resistance, bearing clearances and proper machine applications. Machine repair chapters include data on stator coil and slip ring rotor repairs, balancing of rotating equipment. Allis-Chalmers Mfg. Co.

INSTRUMENTS AND CONTROLS

205 Control Linkage—General Specification CA942, 16 pp, presents control linkage for company's control drive and also contains engineering price data. Explains and illustrates flexible control design drive levers, driven levers, connecting links, bearings and shaft and cable, also rotation over 90 deg. Includes helpful suggestions on selecting linkage and illustrates several typical arrangements. Bailey Meter Co.

206 Boiler Water Level Control — Bulletin 427 describes completely the installation of boiler water level control equipment at the Blackhawk Generating Station, Wisconsin Power & Light Company. Photographs of the installation are presented as is a schematic layout of the entire station. Northern Equipment Co.

207 Instrument and Control Panels — Bulletin 773, 8 pp, explains how company's panels are made and where they are used. All operations of fabrication are discussed and illustrated—layout, cutting, drilling, welding, fitting, painting, wiring. Particular features like electric clocks, pressure gages, transformers, name plates, push-button stations and signal lights are discussed. Also includes many photos of panel installations. The Hays Corp.

208 Remote Reading Flow Meters—Data Book 702, 32 pp, fully illustrates and explains flow measurement problems and offers suggestions for their solution. Meter bodies, differential devices and reading instruments are fully described and a special section is included on wide range and reverse flow. Republic Flow Meters Co.

209 What's Going On Inside?—Sight flow indicators for insertion into pipe lines carrying oil, steam, water, cooling liquids are described in Bulletin DD, 4 pp. Covers both cylinder and window types, gives sizes and prices. Also catalogs gage glasses, tubing, other safety equipment. Ernst Water Column & Gage Co.

210 Flow Meters—Bulletin 400-F2, 8 pp, features company's meter for measurement of steam, air, or gas flow in 1 or 1½ in. pipe lines, and designed for instal-

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lation directly in the line being metered. Illustrated with photos of meter, sectional and dimensional drawings, the bulletin explains how meter operates and discusses its advantages. Gives typical specifications and includes correction factor charts and capacity tables. Builders-Providence, Inc.

211 Pneumatic Metering Element—Company's pneumatic machine used as the metering element in the measurement and control of steam, gas and liquid flow, liquid level, pressure differential and similar applications, is illustrated and described as to application and operating characteristics, in Bulletin 2180. Design and operation of the machine are shown in full color drawing. Dimensional, ordering data included. Hagan Corp.

212 For Practical Men—That's the title of this 24-pp pocket-size booklet presenting insulation testing in simple language. Packed with maintenance hints, it explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in terms of long run economy and prevention of shutdowns. Discusses the Megger as a trouble-shooter, pointing out its functions and telling how to get the most out of it. There's also a chapter on handling wet equipment. James G. Biddle Co.

213 Liquid Level Indicators—Twenty-pp Bulletin WG-1823 is company's newly published edition covering liquid level indicators and auxiliary attachments for remote indication of liquid level in boilers, feed water heaters, storage tanks. Discusses eye-level readings afforded, accurate indication of changes and other advantages of the indicators. Auxiliaries described include automatic control units for operation of distantly located alarm signal lights, horns or electric switches. Provides complete construction and operating details, installation suggestions, dimensions, application diagrams, pictures of typical installations ordering data. Yarnall-Waring Co.

214 Flow Tube—Catalog 80, 4 pp, presents engineering data on a new primary element for measuring, regulating and controlling fluid flow. Tells how these flow tubes are designed and how they function and discusses their advantages. Includes test results covering their use on high main line velocities, medium to low main line velocities and steam and condensate vapors. Foster Engineering Co.

215 Control Equipment—General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pitot equipment. Includes capacity tables, dimensional data, specifications, layout drawings. Simplex Valve and Meter Co.

VALVES, TRAPS, PIPING

216 Piping Materials Catalog—Corrosion resistant valves and piping materials are covered in illustrated circular No. 330, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawing of models, complete specifications, sizes and prices. Includes a description of alloy metals used and a corrosion questionnaire. Also included are condensed recommendations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their parts. Crane Co.

217 Valves Bulletin — Catalog Section 12-H describes various types of company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Details of design including operating mechanism, body design, disk piston, and other features are explained. Dimensional details are given in tabular form accompanied by dimensional line drawings. Edward Valves, Inc.

218 General Service Valves — Bulletin E-160, 16 pp, describes and illustrates the design and construction of company's quick-operating valves, explaining their application to blow-off service and on fire protection, chemical process, soot blower, water column, blow-down, and other types of pipe line. Included are tables of dimensions, weights and list prices for straight lever and rack-and-pinion types, inside packed and with outside stuffing box and with screwed or flanged ends. Everlasting Valve Co.

219 Unions and Fittings — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special construction features and other advantages. Also illustrates all equipment offered, along with sizes, materials, current price list. E. M. Dart Mfg. Co.

220 More Data on Strainers—In response to demand this revised edition, Bulletin S-252, 6 pp, contains greater and more up-to-date data on screwed strainers as well as expanded details on flanged types. Fully illustrated with photos of the strainers and screens used in them, it explains function of the strainers and provides material specifications, pressure and temperature data, dimensions and prices. Also tells how to install strainers and replace screens. Yarnall-Waring Co.

221 Welding Fittings and Flanges—Catalog and Engineering Data Book 211, a 262-pp manual, provides complete dimensional data, weights and prices on company's welding fittings and flanges. The engineering section contains practical, illustrated information covering welding fittings and flanges under varying conditions of temperature and pressure, location and materials processed. Discusses their use in different piping systems.

A section is devoted to welding fittings and flanges in special metals and alloys. The technical section covers properties of pipe, rating of pipe, fittings and flanges, line expansion and flexibility, support and anchorage of piping and flow of fluids.

Distribution of this catalog is limited to major users of industrial piping. (Please include your title when requesting it.) Tube Turns, Inc.

222 Steam Traps and Temperature Controls—Here is a comprehensive catalog comprising many of company's bulletins on steam traps and related equipment, including an illustrated steam trap chart for easy selection of the right trap for each application. Provides data on boiler steam traps, air eliminators, thermostatic steam traps and air vents, inverted bucket steam traps, temperature regulators and cooling controls, steam and water mixers, thermostats and strainers. Generously illustrated with photos, engineering drawings, catalog contains full dimensional and application data, prices. Sarco Co., Inc.

223 Steam, Air, Gasoline Traps—This 32-pp illustrated catalog, No. 250, describes five types of thermostatic steam traps for pressures to 235 lb; expansion steam traps for pressures to 250 lb; weight-operated traps for steam, air and gasoline service, pressures to 1500 lb; piston-operated steam traps for pressures to 650 lbs, and also steam, air and gas separators. Includes capacity tables, installation diagrams as well as a discussion of typical applications, and a section giving data, charts and formulas for determining proper size trap. W. H. Nicholson & Co.

224 Handbook on Fittings and Flanges —Catalog wf-1950, 88 pp, is packed with working information on manufacturer's seamless carbon steel welding fittings and forged steel flanges. In addition to presenting standard schedules with their specifications, list prices and sizes, this book gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings stocked in other metals such as stainless steels, Inconel, pure nickel or Monel, aluminum, deoxidized red brass. Grinnell Co., Inc.

225 How to Choose and Use Air Traps —Bulletin 202, 4 pp, describes manufacturer's complete line of air traps, covering their selection and installation for automatic drainage of moisture from compressed air intercoolers, aftercoolers, receivers, separators, and drip points. Illustrations of the various airtrap models, their applications and how they work are also presented, and physical data and prices included. Armstrong Machine Works.

226 Rubber Expansion Joints — Eight-pp Bulletin AD 137 tells about the application, construction, styles, service and advantages of the company's line of rubber expansion joints. Includes ordering information and a table of dimensions which is accompanied by dimensioned line drawings. The Garlock Packing Co.

227 Flanges for Severe Service — This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Photos and sketches illustrate the flange and its parts. Bulletin also covers a flexible rubber pipe for use with abrasive or corrosive material, as well as an acid- and corrosion-resistant duct, listing solutions this duct will handle. Goodall Rubber Co.

BOILERS AND AUXILIARIES

228 Working Pressure Data Card—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table, Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart is punched for binding. The Babcock & Wilcox Tube Co.

229 Dowtherm Vaporizer—Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer tells how this unit is designed to evaporate Dowtherm in such a way as to provide dependable operation at maximum temperatures, discussing its construction advantages in detail. It is illustrated with photos of the vaporizer and includes a dimensional drawing, vaporizer chart and specifications. Also included is table showing general properties of Dowtherm "A." The Wickes Boiler Co.

230 Tube Expanders—Bulletin 380, 8 pp, covers manufacturer's line of tube expanders for maintenance of high pressure boiler tubes, superheaters, economizers, circulating tubes, steam generators and like equipment. Various models are illustrated by photo and described as to application. Thomas C. Wilson, Inc.

231 Bent Tube Boiler Data—This 20-pp booklet is filled with engineering drawings of recent installation of company's Class VL boilers, designed for adaptation to limited space conditions in plants having diverse steam requirements. Text covers main design features of these bent tube boilers. Henry Vogt Machine Co.

232 Steam Generators—Engineering data on manufacturer's coal, oil, gas or combination fired package units for generating steam up to 35,000 lb per hour is presented in Bulletin PG-49-13, 12 pp. Includes dimensional data and drawings, a discussion of design features and drawings illustrating firing arrangements. Foster Wheeler Corp.

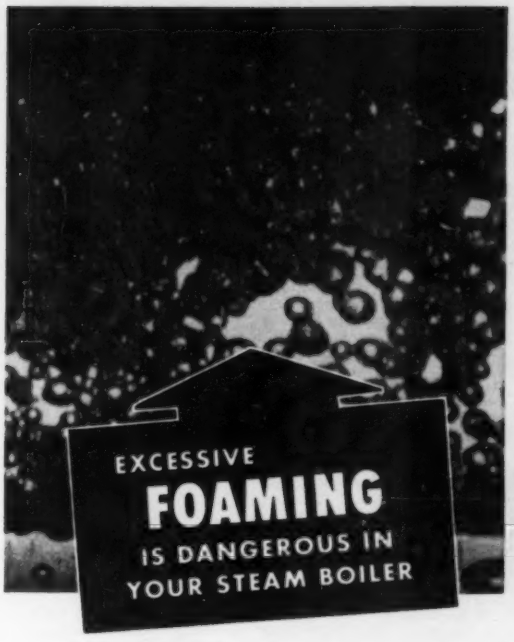
233 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Also includes data on motors and hose for use with cleaners. Roto Div., Elliott Co.

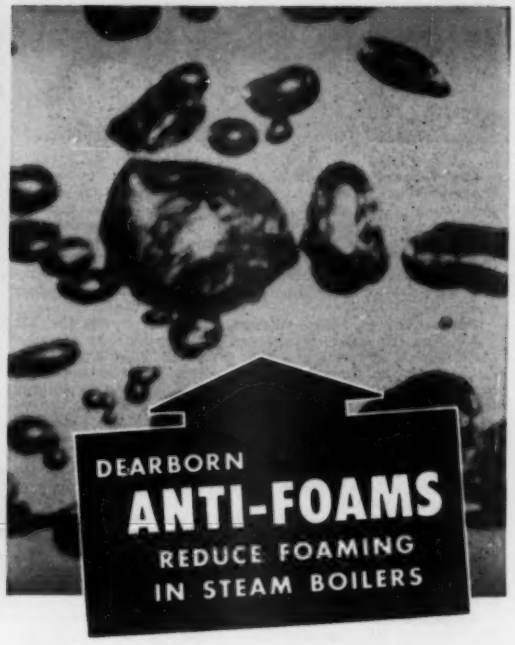
HEATERS, HEATING

234 Tubular Heat Exchangers—Bulletin 916, 32 pp., describes present designs of the company's tubular heaters, coolers, condensers and heat exchangers and their distinctive features. The various types of shells, tube bundles, stationary heads and floating heads are explained. An additional helpful feature are tables of the characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and API. Also presented are charts of specific heats of midcontinent crude oils and for solving MTD formula with correction factors for other than countercurrent conditions. The Griscom-Russell Co.

235 Water Heaters—Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. A typical piping hook-up for installation of these heaters is shown. Also included are instructions for heater selection, engineering data to determine boiler capacities required for heating water, and a chart to determine pipe sizes for any steam flow at most pressures. Davis Engineering Corp.

(Continued on page 116)





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If you use steam in your plant, investigate Dearborn Polyamide Anti-Foams. Dearborn, serving industry since 1887, brings you a complete water treatment and engineering service. This broad experience is at your disposal, whatever your needs in water treatment.

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POWER PLANT Construction News

San Bernardino, Calif.—California Electric Power Co., Riverside, Calif., has authorized plans for new steam-electric generating plant near San Bernardino, with initial capacity of 60,000-kw, consisting of two 30,000-kw turbine-generators, high-pressure boilers and auxiliary equipment. It is expected to install a third generator of same rating at later date. Completion is scheduled by close of 1952. Cost about $8,000,000, with transmission lines, power substations and other facilities.

Cabinet Gorge, Idaho—Washington Water Power Co., 825 Trent Ave., Spokane, Wash., has plans under way for new hydroelectric generating station on Clark Ford River, near Cabinet Gorge, Bonner County, where site has been acquired. Project will include power dam, generating station, with three 50,000-kw hydraulic turbines and electric generators, and accessories, water reservoir, switching station and other facilities, including new high-tension line from plant site to Spokane. Application has been made to Federal Power Commission, Washington, D. C., for permission to proceed with project, which will represent a gross investment of about $40,000,000.

Hutsonville, Ill.—Central Illinois Public Service Co., Illinois Bldg., Springfield, Ill., will carry out expansion in steam-electric generating plant at Hutsonville, including installation of additional turbine-generator unit and accessories. No official estimate of cost announced. Contract is being let for structural steel framing.

Ridgeland, Ill.—Commonwealth Edison Co., 72 West Adams St., Chicago, Ill., has authorized expansion in new steam-electric generating station at Ridgeland, now in course of completion, comprising the installation of a third turbine-generator, 150,000-kw rating, and auxiliary equipment. Work will proceed on completion of initial plant, with capacity of 300,000-kw, scheduled in about 12 months. Entire project will represent a reported investment in excess of $25,000,000, with tranamission lines, switching stations and other operating facilities.

Terre Haute, Ind.—Public Service Co. of Indiana, 110 North Illinois St., Indianapolis, Ind., has plans maturing for new steam-electric generating plant on Wabash River, in vicinity of Terre Haute, to be equipped for a capacity of 180,000-kw, consisting of two 90,000-kw turbine-generator units, high-pressure boilers and auxiliary equipment. Proposed to begin work soon and to complete project early in 1953. Cost reported over $30,000,000, with transmission lines, power substations and other operating facilities.

Baltimore, Md.—Consolidated Gas, Electric Light & Power Co., Lexington Bldg., has approved plans for expansion in local steam-electric power plant on Gould St., with installation of additional equipment for increased capacity. Proposed to begin work soon. Entire project reported to cost close to $2,100,000.

Andover, Mass.—Town School Board, plans boiler plant at new one and multi-story school. Entire project reported to cost approximately $1,000,000. Proposed to ask bids in near future. Tucker & Rich, 45 Newbury St., Boston, Mass., are architects.

Brockton, Mass.—Board of Education plans boiler plant at new West Junior High School for central-heating service. Structure will be two-story, with facilities for about 800 students. Entire project estimated to cost about $1,500,000. J. William Beal Sons, 185 Devonshire St., Boston, Mass., are architects. Proposed to begin work before close of year.

West Springfield, Mass.—Western Massachusetts Electric Co., Springfield, Mass., plans expansion in steam-electric generating station at West Springfield, including new addition and installation of equipment for increased output. Project will represent large expenditure—no official estimate of cost announced. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

St. Clair, Mich.—Detroit Edison Co., 2000 2nd Ave., Detroit, Mich., has authorized construction of new steam-electric generating plant on St. Clair River, near St. Clair, where tract of land has been secured. Plant will have an initial rating of 250,000-kw, consisting of two 125,000-kw turbine-generators, high-pressure boilers and auxiliary equipment. Work will be carried out during 1951. Ultimate plant will have a capacity of about 375,000-kw and will represent a gross investment approximating $35,000,000.

Aurora, Miss.—Minnesota Power & Light Co., 30 West Superior St., Duluth, Minn., has authorized plans for new steam-electric generating plant, near Aurora, where site has been selected on Colby Lake. It will have an initial capacity of 88,000-kw, consisting of two 44,000-kw turbine generator units, with high-pressure boilers and auxiliary equipment. Proposed to have plant ready for operation early in 1953. Cost reported approximately $15,000,000, with transmission lines, power substations and other facilities.

Perth Amboy, N. J.—Public Service Gas & Electric Co., 80 Park Pl., Newark, N. J., has plans under way for extension in steam-electric generating plant at Perth Amboy, with installation of additional equipment for increased capacity. Project will represent large investment—no official estimate of cost announced. It is understood that work will begin early in 1951.

Middletown, N. Y.—State Bureau of Contracts & Accounts, State Office Bldg., Albany, N. Y., has plans for power house at Middletown Homepathic Hospital, for central-heating service. Work will begin soon. No official estimate of cost announced—reported over $225,000.

Shadyside, Ohio—Kaiser-Frazer Corp., Willow Run, Detroit, Mich., automobiles, plans power house at proposed new steel-stamping plant on 65-acre tract of land, fronting on Ohio River, near Shadyside, recently acquired. It will comprise a main one-story building for general production and several auxiliary structures. Entire project reported to cost close to $3,000,000.

Youngstown, Ohio—Republic Steel Corp., Market St., has approved plans for new power plant at local steel mill, to be about 50 x 145 ft and 110 ft high. Installation will include a 15,000-kw turbine generator and accessories, two high-pressure boilers, and auxiliary equipment. Entire program reported to cost over $8,500,000. Completion is scheduled late in 1951. United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia, Pa., is engineer and will be in charge of construction.

Supply, Okla.—State Board of Public Affairs, State Capitol, Oklahoma City, Okla., plans new boiler plant for central-heating service at Western Oklahoma State Hospital, Supply (Woodward County). Estimates of cost are being made. C. E. Bretz, Commerce Exchange Bldg., Oklahoma City, is engineer.

Clarion, Pa.—General State Authority, 18th and Herr Sts., Harrisburg, Pa., has plans maturing for new boiler plant for central-heating service at State Teachers' College, Clarion. Cost reported about $250,000, with boiler units and other equipment. Chester Engineers, Inc., 210 East Pkwy., Pittsburgh, Pa., is engineer.

Villanova, Pa.—Board of Trustees, Villanova College, has plans for new boiler plant for central-heating service at institution, including radial brick stack. Cost reported over $550,000, with boiler units and auxiliary equipment. Scandale, Burkavage & Associates, Lincoln Bldg., Scranton, Pa., are engineers.

Longview, Tex.—Southwestern Gas & Electric Co., Longview, plans expansion in steam-electric power plant at Lake Cherokee, Gregg County, Tex., known as Knox Lee station, with installation of new 35,000-kw turbine-generator and accessory equipment. Work scheduled to be carried out soon. No estimate of cost announced. Main offices of company are at 428 Travis St., Shreveport, La.

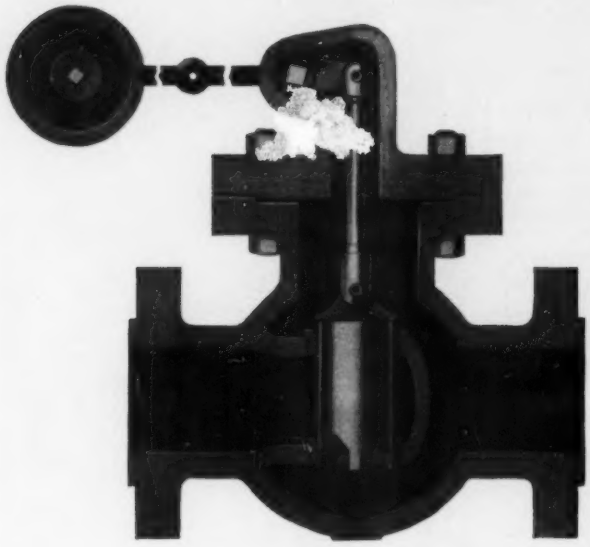
Tyler, Tex.—Texas Power & Light Co., Interurban Bldg., Dallas, Tex., plans expansion in Diesel engine-generating plant at Tyler, including installation of additional equipment for increased capacity. Cost reported close to $250,000. Proposed to begin work soon.

Cedarburg, Wis.—Light & Water Commission has authorized plans and estimates of cost for expansion in municipal oil-operated electric generating plant, with installation of new Diesel engine-generator unit and auxiliary equipment. Gates, Moe, Weiss & Papenthien, 611 North Broadway, Milwaukee, Wis., are engineers, and will make survey at once.

Milwaukee, Wis.—Wisconsin Electric Power Co., Public Service Bldg., has plans under way for new steam-electric generating station, with initial rating of 120,000-kw, comprising a single turbine-generator of that capacity, high-pressure boilers and auxiliary equipment. No announcement has been made of plant site; it is understood that it will be located near Kenosha, with frontage on Lake Michigan, where large tract of land was acquired recently. Entire project is reported to cost close to $20,000,000.

St. Croix Falls, Wis.—Northern States Power Co., 2 South Barstow St., Eau Claire, Wis., has plans maturing for expansion in hydroelectric generating station at St. Croix Falls, with installation of new hydraulic turbine-generator and auxiliary equipment for increased capacity. No estimate of cost announced. Pioneer Service & Engineering Co., 231 South La Salle St., Chicago, Ill., is consulting engineer.

COPES BALANCED VALVES



A valve may be statically balanced while at rest, yet be so badly unbalanced dynamically—when handling flows under pressure—that inaccurate response to the actuating element causes a "hunting" action which makes impossible the desired precision of control. In COPES Valves, unbalanced forces are held within narrow limits over the entire operating range. This is why so many have been purchased *at a premium,* where control must be precise with actuation by float, solenoid or other element. Sizes: ¾-inch and up. When writing for data, give complete information on your operating needs.

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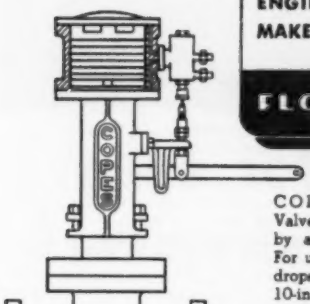
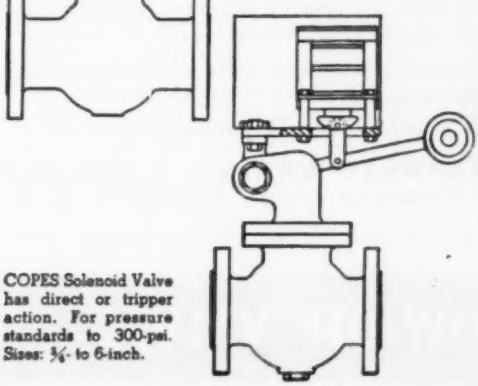


COPES Type SLH Valve, relay operated by air, oil or water. For unlimited pressure drops. Sizes: 1½- t 10-inch.



COPES Solenoid Valve has direct or tripper action. For pressure standards to 300-psi. Sizes: ¼- to 6-inch.

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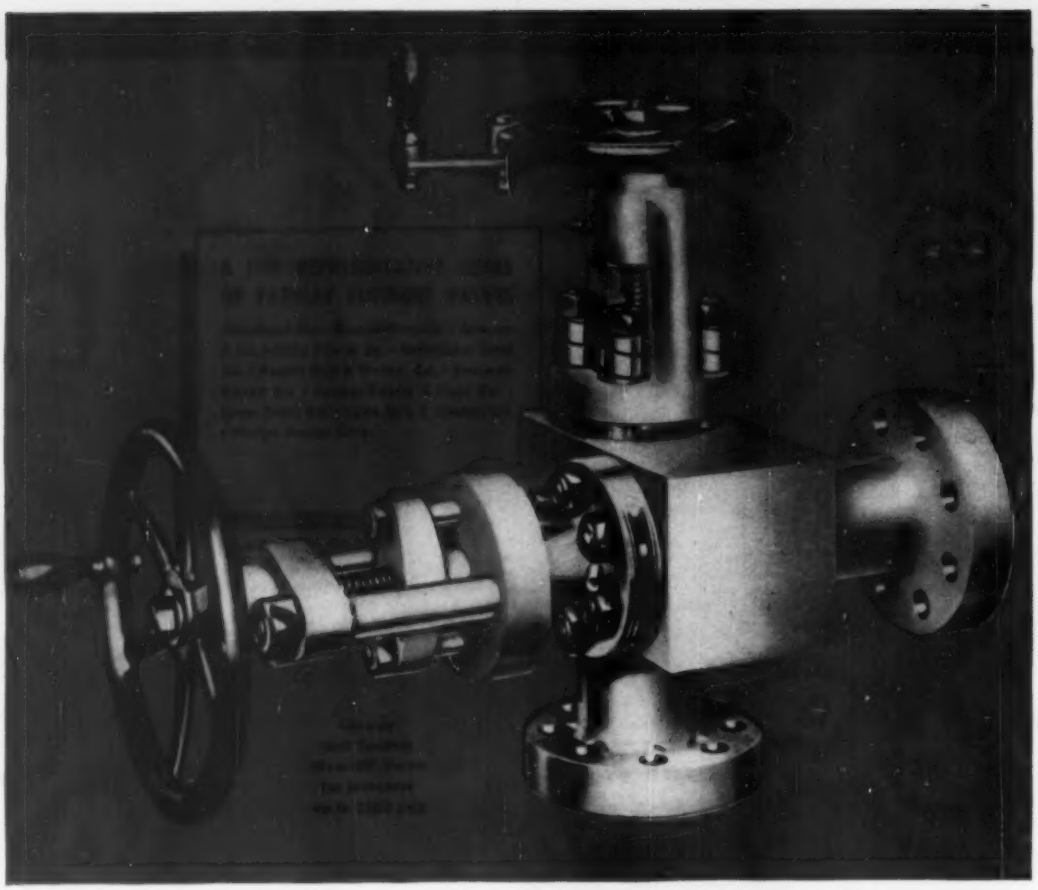


TIGHT! STRONG! for even toughest blow-down requirements

The Yarway Unit Tandem Blow-Off Valve meets the most demanding requirements for boiler blow-down or drain service.

It's drop-tight—and rugged enough to withstand the severe punishment of regular or emergency blow-down under pressure, or periodic acid wash.

Two Yarway Stellite-Seat Hard-Seat Valves or a Hard-Seat (blowing) and Seatless (sealing) Valve are combined in a one-piece forged-steel body. Designed for pressures up to 2500 psi.

It is significant that more than 4 out of 5 high pressure boiler plants use Yarway Blow-Off Valves.

For more facts, see Yarway Bulletin B-432.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.

SEE YARWAY PRODUCTS AT THE NATIONAL POWER SHOW, GRAND CENTRAL PALACE, NEW YORK, NOV. 27 TO DEC. 2. BOOTHS 65 & 66.

YARWAY

BLOW-OFF VALVES

LETTERS TO THE EDITORS

DON'T BE A GENIUS—OR A SKUNK

AFTER reading John Raven's story in the September issue we wondered what or who is a genius. WE think a genius is a misfit anywhere. We too have one.

It is also strange that at various engineering meetings and other places we have heard of the Law of Averages, and heard many tales on how it works. "It's luck that carries him through" is another of those wonderful sayings, even "He must have a guardian angel," and then again the actual and believe it or not, most truthful, "It is not what you know, but who you know."

And so the genius we have in mind must have a couple of divisions of guardian angels, and a freight train load of luck a mile long, and a strong pair of eyes, a glib tongue, and a good pair of legs to circumvent the Law of Averages, which in a million ways should have caught up with him yars and yars ago.

Psychologists write books on this stuff, and the Good Book says to turn the other cheek, and we have tried all ways to help. We have turned our cheeks inside out.

Now we are not blessed with degrees, nor are we blessed with stationary engineers licenses—not all of us. Neither is our genius, but since our job is our bread and butter, we have to put up with his insufferable *Geniusness*. As a consequence we are great in our humiliation.

"Impossible" you will say. "The man must have something." Ah, yes. He has! An unconquerable spirit and therefore a Do or Die ego. For he too must live, and die for his job. "How did he get his job" you will ask, but that too is a secret, but it is oily, and smells like ambergris.

We have carried him on our backs, and have been weighted down by his actions. We have treated him as a prince, and have carried the torch for him to show him the right, but to no avail. We have counselled, and cajoled, but not bootlicked him, for we fear him not when in front of him face to face but when our backs are turned we FEAR him, because he might penalize us by having our tongues torn out, or our ears chopped off.

All of these things can happen to us—not in theory but in actual fact. For he is strong. Is he not the big shot, and we the underlings? His voice is great to behold, but his nerve and the intestinal stuff is weak in emergency. We have seen him pale, then disappear, and leave us to overcome the allaying of a possible catastrophe, while he slinks under the desk.

We fight—not the genius—but the poor maintenance of the boilers. The stokers are listless, and the engines pound and there are no governors. The turbines hunt, screech, and hammer 'cuz their governors have been hammered useless. The feed-pumps wheeze and whirr-r because their regulators were lost on his freight train of luck.

Boiler controls? We have them on a beautiful panel, but that is all. The weigh larry trundles like the Toonerville trolley on spreading tracks with flat wheels and toothless gears. Baling wire is resorted to on the coal spreading system.

Steam lines have burst and nobody hurt. Soot blower valves have blown out, and again—nobody hurt. But one day to show how to empty a boiler quickly, he knocked in a manhole plate, and the scalding water cascaded down on the man underneath. The man went to the hospital. Who was blamed? The man underneath!

A blow-off valve refused to blow-off, when opened up. His deep resonant voice resounded with the order to "Hit the demthing. Hit it with anything." He gave the man a hammer, but the hammer has never been found since that day. The man? Oh yes, he fell off the ladder, and sprained his right hand thumb.

So while we are afraid, yet we are happy. We will always have our genius. Some poor individual raised a squawk, but only squeaked, and he was disbanded, and banished to the basement amongst the ashes. He *was* lucky. 15 cents an hour less.

We are proud to work in a way and in a manner of speaking. For we can see that there is hope for us in these United States. We too may get a big job if we too can lie like a stinker, and be able to stare a man down, and be able to capture the fantasies of the higher ups by telling the noblest falsities in such a grand manner with that basso profundo. (We are attending night school classes to aid us in speaking from our soles.)

But the funny thing about it all, is that the good people, who have our best wishes at heart keep on saying "Have clean thoughts" and to go around—not as martyrs, but with a saintliness of expression, as such things pay off. "Extend the hand of good fellowship" one said to us—only yesterday. (Whattahell — and get it cut off?)

Now we ask you as Editor. What about this Law of Averages? Do you believe in Fairy Godmothers or guardian angels? and Luck?[1]

[1] Not by a long shot.—Ed.

You ask "Where is this plant?" and the answer is "In these good old United States of America" and it is owned and operated by one of those great industries that always "Show the World." Yes they believe in that axiom "Who you know and not what you know" and the funny thing is, that the genius gets the credit (Not us) for his Yankee know how.

"UNICORN'S GANG"
XXXXXX—X2 = 12 men.

VISCOSITY OF NO. 5 OIL

WE HAVE read with interest the article of "Viscosity of Fuel Oils" by Mr. Paul F. Schmidt of the Allied Oil Company, Cleveland, in the August issue of POWER ENGINEERING.

We would particularly like to know the explanation of the oil company's wide range of viscosity listed for number 5 oil. As mechanical contractors, we have installed many oil burning installations and we believe it is of general opinion that the number 5 oil can be burned without heating. However, our experiences, particularly in the last year, indicate that much of our trouble in burning number 5 oil is probably due to the wide variation in viscosity permitted. We have particularly noted that different loads of oil from the same large refineries in this locality appeared to vary so much that new adjustments are frequently required. However, when we have questioned the oil dealers, the general answer has been that there has been no change in the oil supplied by them.

It is apparent from viscosities indicated in his article that number 5 oil might be much more difficult to handle than number 6.

Your comments would be very much appreciated.

Paterson, N. J. R. V. GARNER

MR. SCHMIDT TELLS WHY

THE PRINCIPLE reason for such variations of viscosities of No. 5 oils, is due to the many types of burners and installations that are available. Location of storage tanks, type and amount of tank heating, preheating equipment, and method of operation all tend to regulate the viscosity of the oil.

Using only one grade number to classify many oils of different viscosity is not the best system, so for a more efficient operation, the oil should be purchased on a viscosity basis, thereby obtaining a uniform oil.

Many are of the opinion that a No. 5 oil can be burned without preheating. This is true only when the viscosity is low. As you recall from

(Continued on page 97)

Photo Courtesy Westinghouse Electric Corp.

Engineering

By WILLIAM T. TAYLOR

THE PHENOMENA exhibited by power transmission systems of 120,000-v up to today's maximum of 240,000-v differ widely from those of the lower voltage inductively-dominated power transmission systems. They require the installation of large kva-capacity synchronous condenser machinery at certain receiving ends, which latter form an integral part of the system, and distinction arises from the fact that the voltage at the receiving end (one hundred or more miles away) can be an appreciable percentage higher than that transformed and transmitted at the sending end; moreover, the current can be an appreciable percentage higher than the actual load current. Voltage and current regulation, system reliability and stability, the engineering and the system economics must all be of a higher order than the lower voltage systems.

A decision as to the system and frequency is already established and the line voltage will these days depend on the electric power systems already operating within the area of supply. As regards the transmission distance *limit*, economy only will be dictator, not the distance of transmission; and where the generating power is hydroelectric the distance of transmision as also the maximum kva-capacity delivered will be defined rather by the natural sites and conditions offered, the sale price of energy and the kva yearly demand.

The economic problem involves several independent variables, principal among which are: the distance of transmission; magnitude and nature of the load; the price of the delivered energy; the generating cost of energy; yearly expenses on the investment; the number of circuits and the size, spacing, arrangement of line conductors, span-length of line supports; the factors of safety applied in the design; power factor, etc. Of these, the important variables that will govern the most economical design are the line voltage, the line conductors, spacing of the line supports, voltage and current regulation, and phase compensation. Provision for the latter will be economical when (and only when) the efficiency of transmission is improved and the kva yearly expenses decreased thereby. The power factor has a direct influence on the cost of transmission, but it has a far less influence on the most economical voltage, most economical size of conductors, and the most economical span of line supports. Voltage regulation and the efficiency of very high voltage, large power transmission systems are (or can be) improved by the proper use of synchronous-condenser machinery properly located.

Information Needed For Analysis

To know whether a given electric power transmission system is commercially the best, it is necessary to know the generating cost and sale price and amount of delivered energy. In the determination of the most economical conditions it becomes necessary to establish relation between the different parts of the transmission and transforming system and the variable factors mentioned above, which is no easy task where accuracy is required. Relations may be, and usually are, established for a fixed set of conditions, also a fixed value of the constants contained in them which should be determined (or assumed) from actual practical data to best suit the given locality, conditions, etc. The conditions assumed may be subjected to radical changes — indeed, industrial and financial conditions alone can change the value of energy and the cost of a transmission system or section. Values will differ under different market conditions, different localities, temperature changes, etc., hence they should be chosen with great care after gaining intimate knowledge of the work to be done.

The yearly cost of energy lost in a power transmission system, and the yearly expenses such as interest, depreciation, taxes, etc., on the capital invested take up a large part of the difference between the cost of generating energy and the sale price of the energy per kva-year. The transmission cost involves the sale price of the energy and the total quantity delivered, expressed as

$$C_t = C_e\,(P/e) + kK$$

The cost of that part due to energy loss in the transmission system being $C_r = (L/e) - L$; while the investment cost of the transmission system is $C_s\,(K/P \cos \phi)$ wherein $C_s = k/C_e$. Hence, the kva-year transmission system cost is given by

$$C_t = C_r\,(K/(P \cos \phi) + C_r$$

where

P = kva-year, delivered energy. The maximum yearly amount of energy trans-

Economics of a Nation's Power Transmission System

The economic considerations which underlie the design and construction of modern electrical transmission systems are of a highly complex nature. They involve not only questions of voltage, power, material and reliability but also geography and meteorology. While few of us may be called upon to design high-voltage transmission systems, the main factors underlying their design are of importance to every engineer in the power industry. These factors are considered in this article by William Taylor. Mr. Taylor needs no introduction to the readers of *Power Engineering*. In recent years he has contributed an important series of articles on the design of armature windings. To older electrical engineers he is best known, perhaps, for his book "Transformer Practice" which is still a classic when it comes to explaining transformer windings and connections. During the war he was an official of the United Kingdom and Canada Technical Mission in New York. He now lives in Durban, S. Africa

mitted in kw-hours = kw × load factor × 8760; for 100% load factor, the kw-year is (P cos ϕ) × 8760.

K = amount of money invested, or total capital cost of the system.

C_e = cost of generating, per kva-year.

k = yearly expenses; made up of total interest, depreciation, taxes, etc., on the total investment. The total percentage allowance for yearly expenses will differ for different parts of the transmission system.

Cos ϕ = average power factor of the transmission system; this cost is practically inversely proportional to the power factor.

e = transmission system efficiency, i.e., ratio of the receiver load to that generated and transformed. High efficiency means less loss; on the other hand, it can mean a more costly system and usually a more reliable system, and one offering better voltage regulation and stability. For instance: we may apply better factors of safety, install duplicate transmission lines or units in the stations, better lightning protection, greater synchronous-condenser and phase-compensation capacity, etc.

The total energy loss is ordinarily given in terms of load conditions at the receiving end; the total loss will also include charging current, corona and leakage current. The load at the generating end would represent the sum of the total losses and the receiver loads. A decrease in energy loss in the transmission system, or a decrease in the item $(L/e) - L$, which is the same thing as an increase in e, can be brought about by increasing K (provided the extra investment is made in the proper direction), or it can be made by decreasing P; the object in any case is that of determining the most economical conditions. The total cost items would be made up of the ohmic and magnetic losses, the charging current, corona and leakage in the transmission lines and transformers, as well as the yearly expense-maintenance of the line-conductors, their insulators and supports, and all other items required to make up the complete transmission system yearly cost. The transmission cost due to energy loss is expressed

$$C_p = R_c + T_c + T_m$$

where

C_p = cost due to energy loss in the transmission system;

R_c = cost due to ohmic loss in the line conductors;

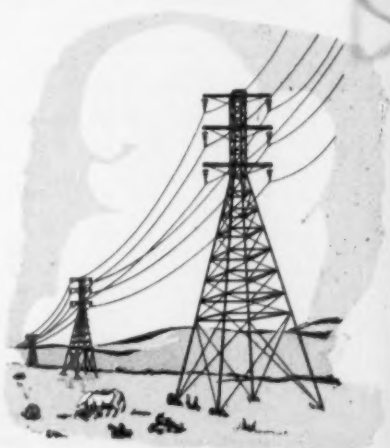
T_c = cost due to the sum of copper losses in the transformers;

T_m = cost due to the sum of core losses in the transformers.

This energy is variable according to the variation of power and power factor, number of transformers in service and their time-period in service, etc., and the total energy loss per kva-year is dependent upon the ohmic loss in the line conductors and the magnetic losses in the transformers, as also the load factor of the transmission system as a whole. The ohmic loss in the conductors depends on the power transmitted, the load and line power-factors, the size and length of the conductors, etc. Ohmic loss in the transformers depends *only* on the amount and nature of the load carried; the magnetic losses are practically independent of the load.

Factors Involved in Transmission Line Cost

In arriving at the cost of a transmission system it is better to divide the system into two parts, one consisting of the transmission line which is made up of the line conductors,



line supports complete with stays and struts, etc., insulators, ground wires, telephone and carrier wires, wayleaves, etc.; the other part consisting of various station costs, transformers, switchgear complete with accessories, lightning protection equipment, buildings, lands, and so forth. The latter cost is practically independent of the distance of transmission, which is a good reason for dividing the whole system-costs into two separate parts because the former cost is proportional to the distance of transmission. For line voltage of this magnitude (above 100,000-v) the percentage cost of line conductors and their supports will usually represent at least double the combined cost of insulators, telephone and carrier circuits, wayleaves, etc. For first quality materials, construction and layout, the percentage cost of transformers, switchgear complete, and building with land will be about equally divided.

The kva-capacity of a transmission system is directly proportional to the cross-section of the line conductors and inversely proportional to the yearly cost. Compared with the total cost of the transmission system the transmission-line cost will increase as its length increases. For the most economical transmission the line voltage should increase with an increase in kva fixed demands, distance of transmission, cost of energy and the load factor, but with decrease in yearly expenses such as interest, depreciation, taxes, etc., on the total investment. The cost of line conductors will be proportional to their length and cross-section; the cost being expressed

$$C_c = N.L.A$$

where

C_c = cost of conductors of a given sectional area;
L = length of conductors, one way;
A = sectional area of conductors;
N = number of conductors.

Size of conductors will (or should) increase with increase in the kva capacity, with increase in the cost of energy, and an increase in the load factor for the most economical transmission. When the load factor is high, the ohmic loss will tend to increase and the yearly expense on the investment decrease, calling for a higher voltage and large size conductors.

A standard wood pole transmission tower

The cost of line supports is composed of the supports, foundations, lands, easements, and their erection cost. The total cost will vary according to the market conditions, line voltage, allowable stresses, angles in the line, span lengths, locality, climate and temperature conditions. The yearly cost will be high when the span of line supports is too long, and the yearly cost will be high when the span of line supports is too short for certain sizes of conductors. The cost of line supports will increase directly with the increase in vertical and transverse loads, etc; the cost being expressed

$$C_s' = N(c + F + L + H)$$

where

C_s' = cost of the line supports;
c = cost of transport and haulage;
F = cost of erection and foundations;
L = cost of line supports and structures;
H = cost of hardware and crossarms;
N = number of line supports completely fitted.

The cost of lands and easements are not taken into account as these items are normally treated independently.

The height of line supports depends upon the line voltage, locality and topography, sag, span, temperature range, and the minimum height allowable by law. Line supports are high when the line voltage is high and the span and sag great. There is a minimum height independent of line voltage, span, sag, and the separation of line conductors; the effective height involves these conditions which may be expressed as

$$h_m = xE + ys^2$$

where

E = line voltage
s^2 = square of the span length between line supports;
h_m = minimum height independent of E and s;
x = a *constant;* and y = another *constant.*

As regards variables such as line voltage, sag of line conductors and span of line supports, the cost of line supports such as steel has to be considered in the light of different kinds of mechanical stresses, weight of the structure itself, windage, vertical and longitudinal and transverse loads, as well as other factors that influence the total weight and cost of the supports and their erection, as also the grade and cost of their foundations. The most economical span of line supports will be defined by this cost and the cost of line insulation, etc.

The cost of insulators is dependent on type and size and weight, which latter is dependent on the line voltage and the insulating capacity that defines the cost. Where there are a number of porcelain bodies, metal pins and caps, as in the case of suspension type insulators, $C_i = N'C_s'$, where N' is number of units. The cost may be expressed in terms of either unit voltage of the string or the line voltage for the complete string of units.

The cost of transformers will be made up of copper, iron, and insulating materials. The cost due to kva capacity will consist of copper and iron. The cost of insulation will be independent of the total area of copper surface and the depth or thickness of insulation; the cost should be small compared with the copper and iron. It should be proportional to the voltage and the square root of the kva capacity, but independent of the induced voltage per turn of the windings, though the induced voltage is proportional to the square root of the kva capacity. When the kva capacity is great the induced voltage should also be great to satisfy the most economical conditions. The total increase in cost for an increase in voltage differs in magnitude for different kva capacity and voltage; hence it is reasonable to assume a condition so that a factor x(P) of a transformer is made up of that part of the cost which is independent of the line voltage, and a factor y(EP) that is part of the cost added by the increase in voltage which is almost entirely dependent upon E but very little on the kva capacity of the transformer. Transformer cost may therefore be expressed

$$C_T = x(P) + y(EP)$$

where

C_T = total transformer cost;
P = kva capacity of the transformers;
E = average line voltage;
x(P) = a factor representing that cost which is independent of the voltage;
y(EP) = a factor representing cost which is added to the increase in voltage;

Hence, C_TN will represent the total cost of transformers; wherein, N is the number of transformer units.

The cost of rights of way, telephone and carrier circuits, ground wires and other items of cost which can be classed as miscellanous to the power transmission line proper, will more often increase with the kva capacity of transmission, and increase directly proportional to the transmission distance. This cost may be expressed

$$C_m = x(L + yP)L$$

where

L = distance of transmission;
P = kva capacity of transmission;
x, y = *constants*.

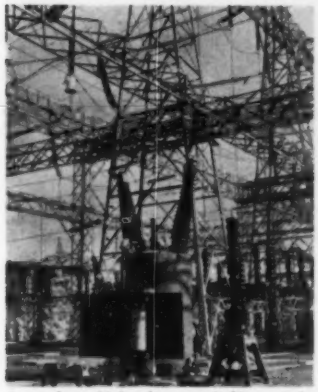
With the exception of the transformers and high-voltage switchgear, the cost of the whole part of the transmission system that is practically proportional to the distance of transmission can be expressed

$$C = C_c + C_s + C_i + C_m$$

where

C_c = cost of given size of conductors for given system;
C_s = cost of given line supports, foundations and erection;
C_i = cost of line insulators complete;
C_m = cost of wayleaves and miscellaneous.

The life of the various parts of a transmission system depends upon a number of diverse conditions, the principal among which are: kind and quality of materials and workmanship, climatic conditions, chemical action, class and amount of protective equipment used, severity of the handling during erection and transit, and the severity of electrical and mechanical stresses during operation. Under reasonably good conditions and for good quality materials, the life in years and the percentage yearly charges of the whole of that part of the transmission system (the cost of which is proportional to the transmission distance or length) is detailed elsewhere as a guidance *only*.



A modern high-voltage switching station

Summary

From the viewpoint of cost of energy losses in transmission and yearly expenses on the capital invested, etc., a summary of the major transmission conditions is given below:

For a definite kva capacity, line voltage and distance of transmission, the yearly expense of ohmic loss in the line conductors will decrease with an increase in the size of the conductors, and *vice-versa*.

For a definite generating cost of energy, distance of transmission and total kva capacity, there is a minimum cost for a definite line voltage and certain size of line conductors.

For a definite kva capacity, generating cost of energy per kva-year, distance of transmission and definite line voltage, the minimum cost of transmission will decrease with increase in the size of line conductors up to a certain cross-sectional area.

For a definite kva capacity and transmission distance, an increase in the generating cost of energy per kva-year for minimum cost of transmission will result in a larger size of conductor for a given transmission voltage.

For a definite transmission distance and kva capacity and given line voltage, the size of conductors will increase with an increase in the generating costs of energy per kva-year.

For a definite kva capacity, transmission distance and generating cost of energy per kva-year, an increase in line voltage will result in a decrease in the size of line conductors.

For a given percentage power loss, transmission distance and line voltage, the yearly charges per kw on all the terminal apparatus and equipment increases at a less rate than the power output of the system.

For a given line voltage the effective height of line supports will decrease with a decrease in span length, and *vice-versa*.

For a given span of line supports, the effective height of the supports must be increased for an increase in line voltage.

For a given span of line supports the vertical and transverse loads will decrease with a decrease in the size of line conductors, and *vice-versa*.

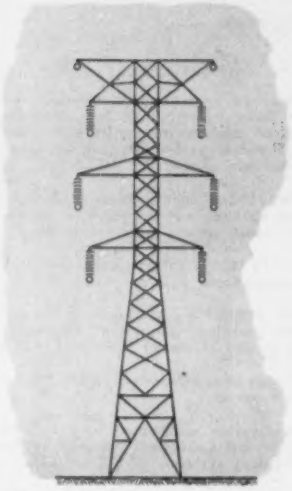
For an increase in span of line supports and definite size of line conductors, the vertical and transverse loads will increase.

For definite size of line conductors, line voltage and transmission distance, there is a minimum yearly expense for a certain span of the line supports.

For a definite span of line supports, line voltage and transmission distance, the yearly cost of line supports will increase with an increase in the size of line conductors.

For an increase in the kva output, the size of line conductors must be increased in the same proportion for the most economical transmission, hence the cost per kw due to the line supports and hardware will increase with the transmission distance.

For a definite power in kva, transmission distance and generating cost of energy per kva-year, the minimum cost for a given span of line supports will increase with increase in the size of line conductors, but the increase in cost will be less for a lower line voltage and shorter span of line supports.



A double circuit, 3-phase steel-tower transmission tower

For a definite cross-sectional area of conductors and generating cost of energy per kva-year, there is a minimum cost of transmission for a certain span of line supports.

For a definite yearly generating cost of energy, transmission distance and total kva capacity, there is a minimum cost for a certain line voltage.

For a definite span of line supports the cost of line insulators will increase with an increase in line voltage. And for any line voltage the cost will increase with a decrease in the span of line supports.

For the suspension type of insulator the cost curve will be similar in form to that of the pin type used for lower voltages. The rated voltage and the number of suspension insulator-units forming the string will increase with the line voltage.

For a given line voltage the cost is a minimum for a certain size and number of insulated units.

The cost of a transformer (or transformers) will increase with the increase in line voltage and kva capacity. When the kva capacity increases the cost will increase due to the increase in the mean lengths of active materials and the sectional areas. When the voltage increases, the mean length of copper will increase while its sectional area will decrease slightly, but the volume of iron will increase greatly. The losses in transformers will be (for all practical purposes) independent of the line

(Continued on page 110)

Features of Sunbury

Pulverized anthracite is principal fuel but three fuels can be burned in any desired mixture: prepared anthracite, unprepared anthracite silt or slush, bituminous coal

2,000,000-ton coal storage area; large coal handling and preparation system. Hot water sprays thaw frozen cars

Two 75,000-kw turbine generators; hydrogen-cooled 13.8 kv generators

Four 400,000-lb-per-hr boilers, largest units burning pulverized anthracite, generating steam at 1350 psig, 955 F

Furnace heat release only 8520 Btu per cu ft per hr

Combination mechanical and electrostatic dust collectors; flue-dust carbon reburning system

Separate generator excitation system

Centralization of all automatic controls and instruments

Priming system for circulators, raw water pumps, main condenser water boxes

Built-in connections for acid cleaning of steam generators

Closed cooling water system for hydrogen and lubricating oil coolers, I-D fan and pulverizer bearings

All electrical auxiliaries; duplicate critical units; auxiliary power through transformers from generator leads

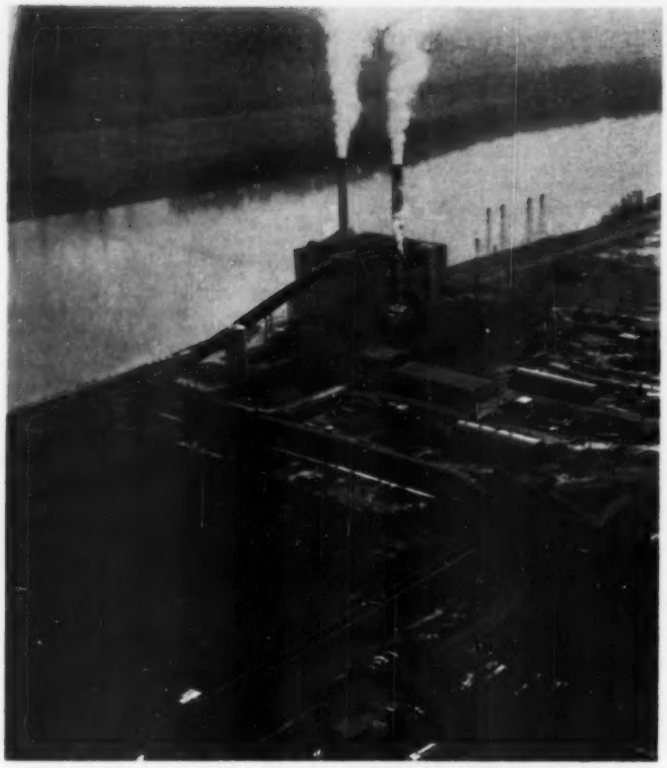


Fig. 1. General view of Sunbury Steam Electric Station, Pennsylvania Power & Light Co. Coal storage and conveyor system in lower left

Sunbury Steam-Electric Station

ON THE Susquehanna River, 3½ miles downstream from the city of Sunbury, Pa., the Pennsylvania Power & Light Co. built its new Sunbury Steam Electric Station and placed its first unit in operation in September 1949, the second in November 1949. The station has an initial capacity of 150,000 kw, soon to be increased by generating units now being installed.

The station was designed for high-efficiency base load operation burning pulverized anthracite as its principal fuel. It is the largest pulverized-anthracite-burning station yet built.

Complete details of the historical background of the station, its place in the system, its architectural and mechanical and electrical features, together with a complete list of all equipment installed, are given in a 44-page, 8½x11-in. illustrated booklet published by the Pennsylvania Power & Light Co. Ask the editors, on your letterhead, how you can get a copy of it.

Ebasco Services Incorporated was the Consulting Engineer and general contractor. That organization was used as an extension of PP&L Engineering and Construction Dept., and all work was under the direct supervision of that department.

A model of the station was constructed as a means of visualizing design problems and Fig. 7 shows a

Fig. 2. View of the coal storage and handling facilities from roof of station. This is one of features of plant

Storage area provided for storing up to 2,000,000 tons of coal. Coal received in railroad cars, handled by fireless locomotives, weighed on track scale, unloaded by car dumper or by car shakeout into track hopper. From hopper, coal is delivered by duplicate belt conveyor to crusher house, thence after crushing, to either plant bunkers or storage area. All coal handling system controlled from central control panel in crusher house. Frozen coal cars thawed in thawing shed by spraying cars with hot water.

portion of this model. It proved most useful in eliminating interferences and undesirable features, in studying illumination and locating smaller units of equipment and controls.

Also, during construction of the station, a most interesting color motion picture was made showing every step in putting the station together.

The station has a most cheerful interior color scheme, good lighting, adequate ventilation and heating everywhere, adequate working space and handling equipment for heavy pieces, fine locker rooms and sanitation facilities, lunch facilities, parking space—altogether a most modern and pleasant place for operators to work in.

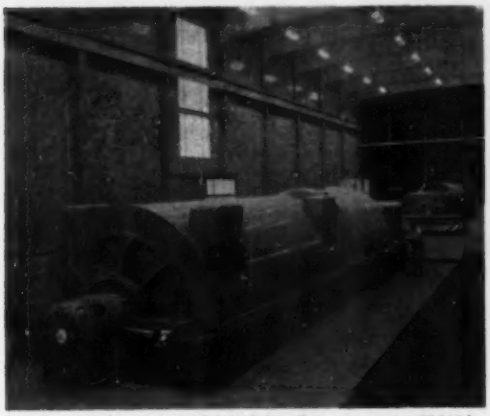


Fig. 3. In turbine room of initial installation are two 75,000-kw, 1250 psig, 950-F steam turbine generator units. Additional generating units plannned for near future

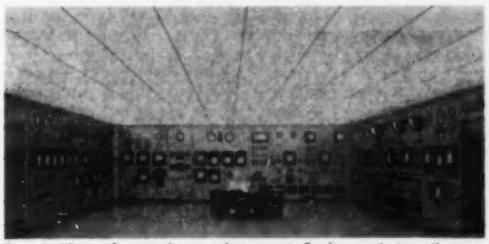


Fig. 4. View of central control room at Sunbury. Automatic controls as nearly complete as possible

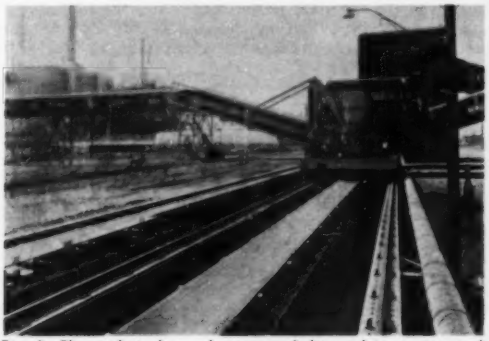


Fig. 5. The coal stacker and conveyor belts used to convey coal to storage area

Coal is conveyed to storage by a 1000-ft belt with traveling stacker that deposits coal along stacker runway, whence it is moved to storage pile by bulldozers or carryalls. To reclaim coal, same bulldozers push it to reclaiming hoppers from which conveyor system returns it to plant.

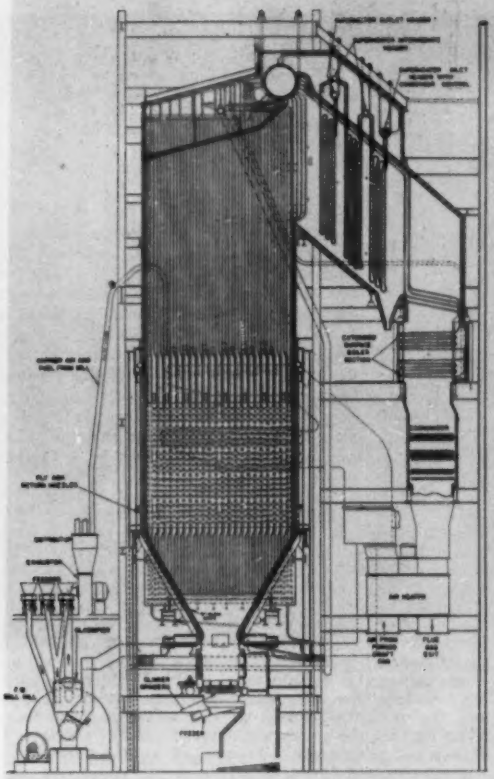


Fig. 6. Cross-section through one of four 400,000-lb-per-hr, 1350 psig, 955-F steam generating units. Furnaces completely water-cooled; heat release 8520 Btu per cu ft per hr at full capacity. Vertical firing at both sides. Each boiler has two ball and tube pulverizers each having two exhausters and six feeders for mixing coals. Steam temperature controlled by condenser type control in superheater inlet header

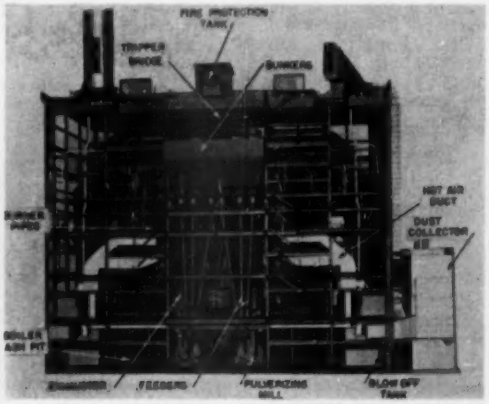


Fig. 7. View of half of model of steam-generating section of station. Bunkers divided into five rows, 40 pockets; outer rows hold prepared anthracite; next two anthracite silt; middle, bituminous coal. Large diameter coal chutes lead almost vertically down to pulverizers, to deliver any or all of three coals to make desired mixture. Only a few operating levels; relatively small operating crew; controls centralized in control room of Fig. 4

IGOR J. KARASSIK Explains

How Centrifugal Boiler Feed Pumps Work

Centrifugal boiler feed pumps operate as they do because of their performance characteristics—that is the definite relations between capacity, head, horsepower input and speed . . . Author explains these relations in detail, showing typical performance characteristic curves and how they are used . . . How the separate pumps must operate when in parallel . . . What is best efficiency point and how is it related to reliability? . . . Characteristic curves and guarantees . . . Reliability is of highest importance, may outweigh other factors . . . How to select driver for centrifugal boiler feed pump, having definite maximum capacity . . . Motor drive, turbine drive, variable-speed coupling . . . This article carries on explanation given by author in September issue under How to Select Centrifugal Boiler Feed Pumps . . . Mr. Karassik is Assistant to the Manager, Centrifugal Pump Division, Worthington Pump and Machinery Corp. and is an authority on centrifugal pumps and their uses

ALL CENTRIFUGAL PUMPS have a definite relation between capacity, head and horsepower input at a given rotational speed; and a change in any one value affects the others in a definite manner. This relation constitutes a pump's performance characteristics. The accepted practice in representing these characteristics is to plot the total head in feet, the horsepower input and the pump efficiency as ordinates against the pump capacity in gallons per minute as the abscissa at a given constant speed, as in Fig. 1. This represents the performance of a 4-in., 4-stage boiler feed pump designed to handle 450 gpm of 212 F feedwater against a total head of 1200 ft when operating at 3560 rpm. Efficiency at these conditions is 72 per cent and the horsepower input is 181. Figure 1 also shows the best efficiency of the pump occurs at a capacity of 550 gpm when the total head is 1120 ft, the efficiency 74 per cent and the power input 202 hp. Thus, the design conditions of this pump lie to the left of the capacity at best efficiency.

If the operating conditions, namely, the capacity, head, efficiency and power input, at which the efficiency curve reaches its maximum are taken as the 100 per cent standard of comparison, the head-capacity, power-capacity and efficiency-capacity curves can all be plotted in terms of the percentage of their respective values at the maximum efficiency capacity. Such a set of curves represents the "type characteristic" of the pump and Fig. 2 shows the type characteristic of the pump described in Fig. 1.

These two methods of representing the performance characteristic of a given centrifugal pump serve to illustrate the difference between "design conditions" and "maximum efficiency" conditions. The latter are defined by the physical dimensions and design features of the pump while the former represent the desired operating conditions dictated by the nature of the installation to which the pump is applied.

Slope of the Head-Capacity Curve

At constant speed, the capacity of a centrifugal pump varies with the head, the capacity increasing as the head decreases. Actual slope of the head-capacity curve, from 100 per cent capacity to no-load, depends primarily upon the type of the pump; in other words, upon its specific speed. While it can be varied somewhat by the choice of certain design factors, only minor variations are permissible without seriously affecting the pump efficiency. Since the slope of the horsepower input and pump efficiency curves depend upon the slope of the head-capacity curve they are also fixed within certain limits by the specific speed of the pump.

In the range of specific speeds normally encountered in multistage centrifugal boiler feed pumps, the rise of the head from the point of best efficiency to shut-off will run from 10 to 25 per cent. Further, the shape of the head-capacity curve for these pumps is such that the drop in head is very slow at low capacities, accelerating as the capacity is increased. This is clearly shown in Fig. 2, where the head at shut-off is 121 per cent of that at best efficiency and has dropped to only 115 per cent at 50 per cent capacity.

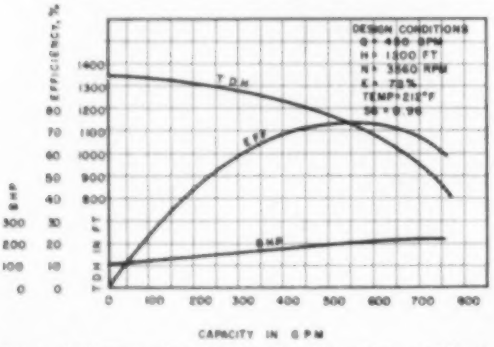


Fig. 1. Performance characteristics of a 4-in., 4-stage centrifugal boiler feed pump

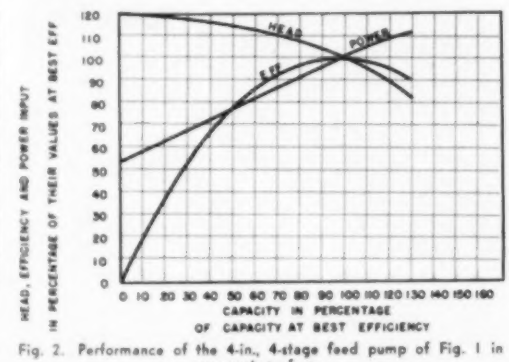

HEAD
POWER
EFF
HEAD, EFFICIENCY AND POWER INPUT IN PERCENTAGE OF THEIR VALUES AT BEST EFF
CAPACITY IN PERCENTAGE OF CAPACITY AT BEST EFFICIENCY

Fig. 2. Performance of the 4-in., 4-stage feed pump of Fig. 1 in percentage form

It is true that, in the case of boiler feed pumps operated at constant speed, the difference in pressure between the pump head-capacity curve and the system-head curve must be throttled by the boiler feedwater level regulator. Thus, the higher the rise of head towards shut-off, the more pressure must be throttled off and, theoretically, wasted.

Also with a higher rise, the pressure to which the piping is subjected is greater. However, it is not advisable to seek too low a rise, as several disadvantages may result therefrom. In the first place, too flat a curve is not conducive to a satisfactory and stable control with the feedwater regulator, for a small change in pressure corresponds to a relatively great change in capacity and such a condition may lead to severe hunting of the control. In addition, an impeller design which gives a very low rise to shut-off may easily result in an unstable head-capacity curve difficult to use for parallel operation.

What if Speed Is Not Constant?

There is another important matter to consider in connection with performance characteristics and the rise to shut-off. Generally these characteristics are plotted at that constant speed which corresponds to the full load conditions. In actuality, however, the pump prime movers do not operate at a strictly constant speed. An average squirrel cage motor will have a decrease in slip between full load and the power demand at shut-off. This decrease is such that the speed at shut-off may be from 1 to 1.5 per cent greater than at full load.

Since the head generated by a centrifugal pump varies as the square of the speed, the actual head at shut-off may be from 2 to 3 per cent higher than that at constant speed. Similar considerations apply as well to steam turbines equipped with constant speed governors. If the power plant designer wishes to calculate the possible piping stresses very accurately, it becomes necessary to take this increase in operating speed and the consequent increase in shut-off pressure into consideration.

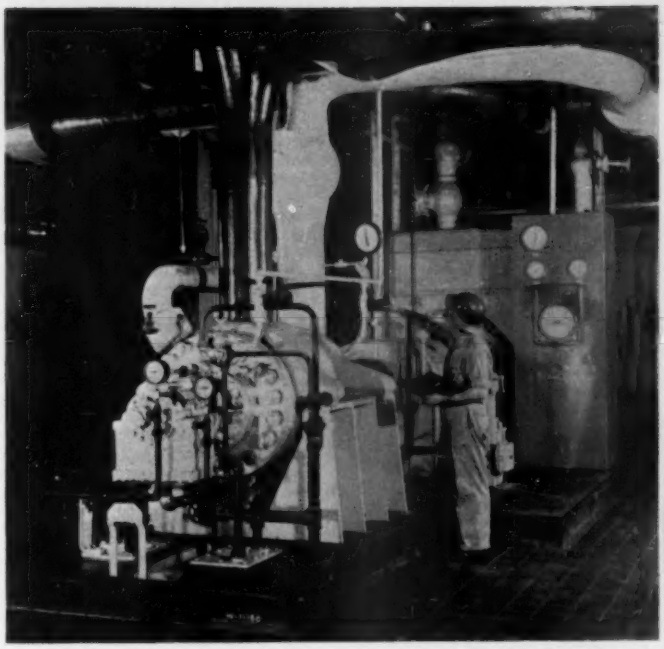


Fig. 4. One of six 6-in. solid-forged-steel barrel, 6-stage, 475,000-lb-per-hr, 325-F water boiler feed pumps at Trenton Channel plant of The Detroit Edison Co. Suction 455 psi, discharge 1835 psi—Driven by 1800-hp motors, through hydraulic couplings. Motor shaft extended to drive heater feed pump at constant speed

Requirements for Parallel Operation

The fact that a pump has a steep curve and a high percentage of rise to shut-off does not necessarily prove that this pump is suitable for parallel operation. It is necessary to

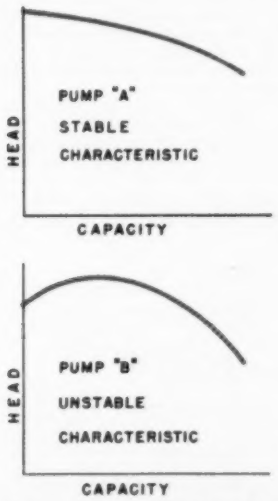


Fig. 3. Definition of stable and unstable head-capacity curves

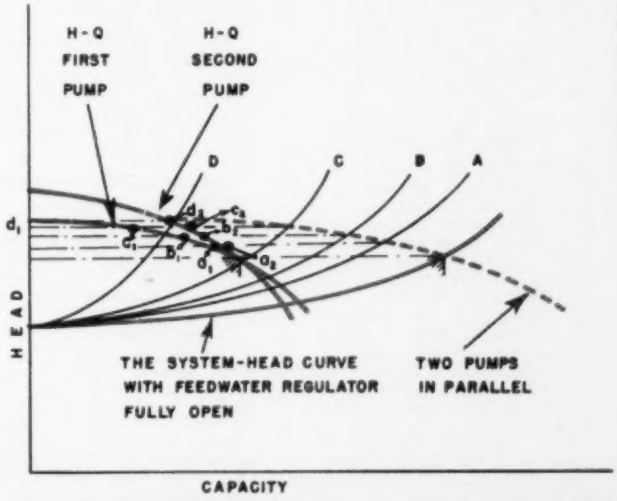


Fig. 5. These two pumps have characteristics poorly suited for parallel operation, as explained in text, page 62

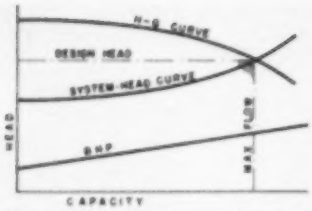


Fig. 6. How to determine maximum brake horsepower of boiler feed pump

distinguish between two basic types of head-capacity characteristics: the stable and the unstable types, illustrated in Fig. 3. Pump "A" has a stable, steady rising head capacity curve, characterized by the fact that it is continually rising from full load to zero delivery and that at no capacity does the total head exceed the head generated at shut-off. If, on the other hand, the constant speed head-capacity curve has a droop between full load and shut-off, as in the case of pump "B," the curve becomes unstable, since it can deliver two different capacities at the same pressure.

When several boiler feed pumps operate in parallel, the head-capacity curve must be a stable one. In the contrary case, the total flow may become unevenly divided between the several pumps and one or more of the pumps may actually cease to deliver after a change in the total required capacity at light flows.

Another possible difficulty arising from the installation of pumps with unstable "drooping" characteristics, such as pump "B" on Fig. 3, is the fact that when one of the pumps operates at relatively light loads near the maximum total head, a second pump, which had been idle up to then, cannot be brought on the line after starting up, because the head it generates at no flow is less than the head developed by the pump running. Thus the pressure in the common header prevents lifting the check valve of the pump that has just been started up.

Parallel Pumps Should Have Similar Characteristics

Further, pumps operating in parallel should have, as nearly as possible, similiar head-capacity curves and equal head at shut-off. Assume two pumps, to be operated in parallel, at constant speed, with no controlling mechanism, such as an excess-pressure regulator, between the pumps and the common discharge header. Now if one of the pumps has a much higher rise in head at shut-off than the other, the possibility arises that the pump with the steeper head capacity curve will back the other pump off the line as soon as the head developed by the pump with the steeper curve exceeds the maximum head developed by the second pump.

The net result would be that the check valve of the second pump would slam shut and the pump operate at shut-off, an unfortunate and generally fatal occurrence if the by-pass to the source of suction happens to be closed at that time. As a matter of fact, even if we were not to consider the danger of a pump being backed off the line (in other words, if the by-pass were to be always open with two pumps operating in parallel) the pumps would not subdivide the total load proportionately.

This fact is illustrated graphically in Fig. 5, where pump No. 2 has a much higher shut-off head than Pump No. 1. The operation of the two pumps in parallel takes place at the intersection of their combined head-capacity curve and the series of system-head curves resulting from the operation of the feedwater regulator. Thus curves A, B, C and D are the corrected system head curves obtained by the throttling action of the regulator.

What Happens When Wrong Pumps Are Paralleled?

As soon as the boiler demand decreases below its maximum, the total load becomes less and less equally divided between the two pumps. The individual pump capacities corresponding to the total flow with the various system-head curves A to D are labeled with the correspondingly lower case letters with subscript (1) for pump No. 1 and (2) for pump No. 2.

For instance, when the demand falls to a value corresponding to that regulator position which results in curve C, Pump No. 1 handles c_1 gpm while Pump No. 2 handles c_2 gpm, a considerably larger share of the total load. Finally, when the demand falls to a value corresponding to curve D, Pump No. 1 can no longer develop sufficient head and operates at shut-off, with pump No. 2 carrying the full load.

Whether or not it is contemplated to operate two or more boiler feed pumps in parallel, the performance characteristics of these pumps should be suitable to this purpose, since any plans for future expansion necessitate parallel operation.

How to Specify Pump Correctly

There are numerous ways of wording the desired requirements of a steady rising head-capacity curve and the following is only a typical suggested form, which can be used in the preparation of boiler feed pump specifications.

"These pumps shall be guaranteed to parallel each other as well as other similar pumps designed for the same conditions of service. They shall be designed, therefore, to exhibit a continuously rising head characteristic from maximum capacity to shut-off. The percentage of rise of the total head from design conditions to shut-off need not be greater than that required to insure proper paralleling and full pump stability at all loads."

If the pump to be installed is required to parallel existing equipment, it is imperative to include with the specifications the actual performance curve of the units already installed and to specify that: "This pump (or these pumps) shall be designed and guaranteed to operate satisfactorily in parallel with existing pumps, the head-characteristics of which are shown on the attached curve sheet."

Location of the Best Efficiency Point

It has been stated that in practically all installations the normal operating capacity corresponds to anywhere from 75 to 90 per cent of the design capacity of the pump. As a result, it is not surprising that frequently boiler feed pump specifications will request the best efficiency of the pump to be located at some intermediate capacity, such as 70 or 80 per cent of the full-load capacity. Except in a few isolated cases, such requirements are not practical in commercial application. When a line of centrifugal multistage boiler feed pumps is laid out, the normal practice is to select the impeller design so that the required net positive suction head (NPSH) at the capacity of best efficiency is of a practical magnitude.

*Since the required NPSH in the normal operating capacity range for a given impeller increases approximately as the square of the capacity, it follows that should the best efficiency be located at say 75 per cent of the full load, the NPSH at full load would be increased by approximately 80 per cent—almost double—over its value at the best efficiency. This in itself would not be a fatal feature, for the direct-contact heater at the suction might be conveniently located sufficiently higher. However, the resultant velocities at the suction of the first stage impeller would have been so increased that the life of this impeller might be somewhat shortened.

In addition, it must be considered that under normal conditions the rise from head at best efficiency to shut-off is of the order of 15 per

*For definition and discussion of NPSH, see How to Select Centrifugal Boiler Feed Pumps, by Igor J. Karassik; POWER ENGINEERING, September, 1950.

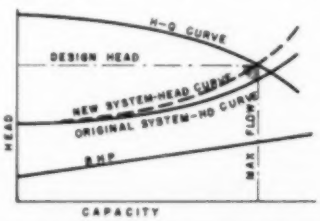


Fig. 7. In determining maximum brake horsepower of pump, dotted line shows effect of feedwater regulator

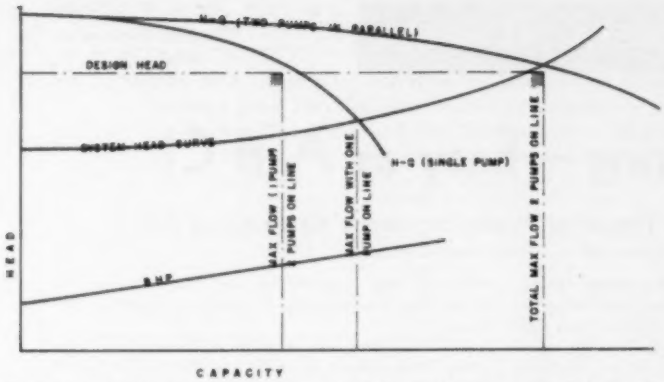


Fig. 8. How to determine driver horsepower for boiler feed pumps operating in parallel

cent. At the same time, while the head capacity curve is very flat at low capacities, it increases in steepness as the capacity is increased. Therefore, if the requirement should be followed and the point of best efficiency located at 80 per cent of the design capacity, the rise from the design head to shut-off may run to as much as 30 per cent or more, with the disadvantages mentioned earlier in this article.

Of course, there are some exceptions in which it may be possible to obviate some of the difficulties mentioned above and provide a design which has its best efficiency at capacities somewhat lower than the maximum design capacity. This becomes more practical in the case of "custom-built" pumps in the higher pressure range—such as 1600 psi and above—as long as one is dealing with appreciably large capacities, say 1200 gpm and above. In addition, the use of variable speed drives —such as turbines, hydraulic couplings or magnetic drives—obviates the disadvantages of excessive rise to shut-off, for in such cases the pump operates against the system head, which descreases at light loads.

Efficiency Evaluations

The subject of efficiency evaluation is extremely controversial and presents some very complex ramifications. As a result, it is possible to present only a few general comments on this subject in this article. There is no doubt, of course, that a pump with higher efficiency will consume less power and therefore entail lower operating costs, at least on paper. It must be considered, however, that the question of efficiency is unalterably linked with that of reliability. In general, it can be stated that the desire for higher efficiencies and that for greater reliability work at cross-purposes to each other.

For instance, one of the great sources of power losses in a centrifugal pump is the disk-horsepower, which is the power expended to drag the impellers through the liquid surrounding them. Because the disk-horsepower losses increase with the fifth power of the impeller diameter, definite power savings can be obtained through the reduction of the head generated by each stage (and, therefore, of the diameter of each individual impeller) and by increasing the number of stages. At the same time, while increasing the pump efficiency which can be obtained for a given set of operating conditions, this increase in the number of stages results in a greater shaft span, greater deflection and a definite decrease in the potential reliability of the pump.

The same considerations arise in connection with two other means available to improve pump efficiency; that is, reduction of the shaft diameter and reduction in operating clearances. Both these solutions affect the pump reliability very seriously. It is rather unfortunate that of the two factors, efficiency and reliability, the first lends itself to arithmetical calculations which can yield a numerical answer in dollars and cents saved, while the second is strictly intangible.

Yet it should be always borne in mind that the reliability of a boiler feed pump is of prime importance in the selection of this equipment and should outweigh any considerations of power savings. As a matter of fact, whenever efficiency improvement is obtained at the cost of sacrificing even the least amount of reliability, any power savings will be purely imaginary. Even if we were to neglect the possible cost of interruption of service, the cost of one extra overhaul during the life of the pump may outweigh all the savings derived from the difference in power consumption.

It should be mentioned, incidentally, that the difference in power consumption between two pumps designed for the same conditions of service is not a net loss, because internal pump losses are transformed into heat energy and are recovered in the feed system. Exact calculations of this recovery are beyond the scope of this article, but a "rule of thumb" is that approximately a third of the losses are recoverable and therefore only two-thirds of the difference represents a net loss.

Evaluating Power Costs

As a matter of fact, evaluation of power costs in the case of a boiler feed pump is somewhat inconsistent with the methods used in selecting pump design conditions. As outlined in an earlier article,* the design capacity is generally chosen at 15 to 20 per cent in excess of the maximum operating boiler conditions. This excess is provided as a margin against boiler swings, against pump wear and as a prerequisite for full power plant reliability. In addition, a margin is frequently provided in the total head at the design capacity. In this wise, a pump operating at constant speed will consume up to 20 per cent more power than would have been required if the pump had been desgined for the exact head and capacity conditions prevailing in the installations. This is as it should be; and the excess in power consumption is a justifiable insurance premium to be paid for full reliability and confidence in the fact that the boiler feed pumps will at all times deliver sufficient capacity to the boiler.

However, in making comparisons between several designs of boiler feed pumps, it becomes a definite inconsistency to penalize any design that, for greater reliability, utilizes less stages, or larger shaft diameters, or greater clearances. This is especially true since differences in efficiency and hence in power consumption resulting from a desire to improve reliability of operation seldom exceed 2 or 3 per cent, a bare tenth or sixth of the excess in power consumption perfectly acceptable to designers when establishing capacity and total head conditions.

Characteristic Curves and Guarantees

Generally, the performance characteristic curves included in a manufacturer's proposal are based on actual tests of similar units and it is expected that they will be very closely met on test. However, small casting and machining variations encountered in commercial type manufacturing are likely to result in small variations in the performance characteristcis. This factor has been wisely recognized by the Hydraulic Institute, the Standards† of which recommend that the pump guarantees be limited to one point (capacity, head and efficiency) and to the statement that the head-

(Continued on page 112)

† *Standards of the Hydraulic Institute*, published by the Hydraulic Institute, 90 West Street, New York 6, N. Y.; price $3.00.

By A. B. STICKNEY
The Rust Engineering Co.
Pittsburgh 19, Pa.

Duct Sizing—Easy as A B C!

All on These Two Pages for Power Engineer's Notebook or File

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ACCOMPANYING TABLES give three factors, A, B and C, which when multiplied together give the flow of air in galvanized ducts for any size, any temperature and pressure of air, and any pressure drop, within the range of the tables. Knowing any three of the four variables in the equation

$$\text{Flow} = A \times B \times C$$

the other can be solved for by simple multiplication or division.

Table I gives the value of A, the flow of "standard air" (0.075 lb per cu ft) in ducts of various sizes, which give a pressure drop of 1/10 of an inch (0.1 in.) of water per 100 linear feet of duct. The values above the heavy line are volumes, thousands of cubic feet per minute, and those below the heavy line are weights, thousands of pounds per hour.

Table II gives the value of B, the multiplier for other temperatures and other barometric pressures than those of "standard air." For each pressure and temperature, two values are given, B_v being the volume multiplier to be used when dealing with volumes, and B_w being the weight multiplier to be used when dealing with weights.

Table III gives the value of C, the multiplier for pressure drops of other than 1/10 in. water per 100 linear feet. The same value applies to either weight or volume.

Example to Show Use of Tables

Suppose we have 100,000 lb per hr of air at 200 F, the barometer is 27 in., and we want a pressure drop of 0.05 in. water per 100 lin. ft. Flow, B and C are known, and

$$A = \frac{\text{Flow}}{B \times C} = \frac{100{,}000}{0.83 \times 0.70} = 172{,}000 \text{ or,}$$

since the values in Table I are in thousands of pounds, = 172

For this value of A, Table I (use the part below the heavy line since we are dealing with weight) shows that ducts 24 in. by 120 in., 30 in. by 96 in., 36 in. by 72 in., or 42 in. by 60 in. could be used. By interpolation,

a square duct $48 + \left(\frac{172-154}{277-154} \times (60-48)\right) = 48 + 1.75 =$ 49.75 in. square could be used, or a round duct

$48 + \left(\frac{172-121}{218-121} \times (60-48)\right) = 48 + 6.3 = 54.3$ in. in diameter could be used. The shape would be determined by space conditions.

Suppose we had the above quantity and condition of air, and a 48-in. square duct. What would the pressure drop be? In this case C is unknown, and

$$C = \frac{\text{Flow}}{A \times B} = \frac{100{,}000}{154{,}000 \times 0.83} = 0.78$$

From Table III, the pressure drop corresponding to C = 0.78 is 0.0626 in. water per 100 linear feet.

Suppose we had the above duct and condition of air, how much air would it handle with a pressure drop of 0.05 in. water per 100 linear feet? In this case A, B and C are known and flow is unknown.

Flow = $A \times B \times C = 154{,}000 \times 0.83 \times 0.70 = 89{,}500$ lb per hr.

Solutions on a volume basis use exactly the same method, the values of A and B being those given for volume.

How to Apply the Method for Moist Air

For moist air, find the specific volume from the psychrometric chart or table, find the temperature of dry air having the same specific volume, and find B for air of this temperature. While this is not theoretically exact, the error will be well within the limits of the accuracy with which pressure drops are calculable.

How to Apply the Method for Flue Gas

Similarly, for flue gases, the densities in general differ from air by less than the probable limits of error of duct friction calculation, and the tables may be used directly.

Here's How the Table Values Were Obtained

If a more exact solution is required for either moist air or flue gas, or if conditions beyond the range of the tables are encountered, the method used in deriving the tables may be used, as outlined below:

d = diameter of round duct, or = $\frac{2ab}{a+b}$ for a rectangular duct a in. by b in.

V = velocity in duct, (feet per minute)

ρ = density of air, lb per cu ft.

μ = absolute viscosity, centipoises. Values for dry air at various temperatures are given in Table at bottom of page.

Re = Reynolds Number, = $2.057 \frac{d V \rho}{\mu}$

f = friction factor, from Colebrook function (using the roughness constant for galvanized ducts)

$$\frac{1}{\sqrt{f}} = -2 \log_{10}\left(\frac{0.00162}{d} + \frac{2.51}{\text{Re}\sqrt{f}}\right)$$

Charts are available from which values of f for various diameters, materials and Reynolds numbers may be obtained.[1] [2] [3]

p = pressure drop, inches water = $0.0010 \frac{f V^2 \rho}{d}$

(1) Moody, Lewis F., Friction Factors for Pipe Flow; *Transactions of ASME*, vol. 66, p 671, 1944.

(2) Stickney, A. B., Friction in Pipes, *Refrigerating Engineering*, vol. 53, p 329, Feb. 1947.

Table for Viscosity of Air, Centipoises

Temp., F	Viscosity	Temp., F	Viscosity
−100	0.0130	500	0.0281
0	0.0161	600	0.0300
100	0.0190	700	0.0318
200	0.0215	800	0.0335
300	0.0238	900	0.0353
400	0.0260	1000	0.0370

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Table I. Values of A, Multiplier for Flow in Galv. Ducts That Gives 1/10" Water Friction Pressure Drop Per 100 Lin Ft with "Standard Air" (0.075 lb per cu ft)

Volume, Thousands of Cubic Feet Per Minute (Above Heavy Line)
Weight, Thousands of Pounds Per Hour (Below Heavy Line)

SIDE OF RECTANGLE	DIAMETER OR SIDE OF RECTANGLE																		
	3"	4"	6"	8"	10"	12"	15"	18"	24"	30"	36"	42"	48"	60"	72"	84"	96"	108"	120"
Round	0.017	0.036	0.108	0.234	0.428	0.689	1.25	2.04	4.32	7.86	12.6	19.0	27.0	48.5	77.4	117.	166.	225.	294.
3"	0.021	0.031	0.052	0.073	0.095	0.117	0.152	0.186	0.253	0.322	0.394	0.464	0.532	0.669	0.807	0.947	1.08	1.22	1.35
4"	0.138	0.046	0.078	0.112	0.147	0.184	0.238	0.294	0.403	0.515	0.626	0.739	0.851	1.07	1.29	1.51	1.73	1.96	2.18
6"	0.233	0.352	0.138	0.202	0.268	0.335	0.440	0.544	0.760	0.980	1.19	1.41	1.63	2.06	2.49	2.93	3.37	3.80	4.24
8"	0.330	0.506	0.909	0.298	0.399	0.507	0.668	0.834	1.17	1.51	1.86	2.20	2.56	3.26	3.97	4.68	5.39	6.08	6.80
10"	0.427	0.662	1.21	1.79	0.544	0.687	0.913	1.14	1.63	2.02	2.63	3.14	3.64	4.66	5.68	6.70	7.74	8.76	9.80
12"	0.529	0.828	1.51	2.28	3.09	0.876	1.17	1.49	2.14	2.79	3.47	4.14	4.81	6.17	7.53	8.90	10.3	11.6	13.0
15"	0.684	1.07	1.98	3.01	4.11	5.29	1.60	2.03	2.93	3.86	4.80	5.75	6.70	8.59	10.6	12.6	14.6	16.5	18.5
18"	0.837	1.32	2.45	3.75	5.14	6.70	9.15	2.60	3.76	4.99	6.19	7.50	8.79	11.4	14.0	16.7	19.3	22.0	24.6
24"	1.14	1.81	3.42	5.26	7.33	9.63	13.2	16.9	5.50	7.41	9.33	11.3	13.3	17.3	21.4	25.7	29.9	34.0	38.3
30"	1.45	2.32	4.41	6.79	9.09	12.5	17.4	22.4	33.3	10.0	12.6	15.3	18.1	23.9	29.7	35.6	41.6	47.6	53.7
36"	1.77	2.82	5.36	8.35	11.8	15.6	21.6	27.8	42.0	56.7	16.1	19.7	23.3	30.8	38.6	46.4	54.3	62.2	70.3
42"	2.09	3.33	6.34	9.90	14.1	18.6	25.9	33.7	51.0	69.0	88.8	24.2	28.7	38.2	47.9	57.7	67.8	78.0	88.1
48"	2.39	3.83	7.32	11.5	16.4	21.6	30.1	39.5	59.8	81.5	105.	129.	34.3	45.7	57.6	69.7	81.8	94.1	107.
60"	3.01	4.80	9.27	14.7	21.0	27.8	38.6	51.2	78.0	107.	139.	172.	206.	61.6	77.7	94.4	111.	129.	149.
72"	3.63	5.80	11.2	17.9	25.6	33.9	47.7	63.0	96.3	134.	174.	216.	259.	350.	98.6	121.	143.	167.	188.
84"	4.26	6.79	13.2	21.1	30.1	40.0	56.6	75.1	116.	160.	209.	259.	314.	425.	544.	148.	176.	205.	237.
96"	4.87	7.79	15.2	24.2	34.8	46.2	65.6	87.0	134.	187.	244.	305.	368.	501.	646.	794.	211.	246.	281.
108"	5.48	8.80	17.1	27.4	39.4	52.4	74.3	99.0	153.	214.	280.	351	423.	580.	750.	922.	1110.	287.	328.
120"	6.08	9.81	19.1	30.6	44.1	58.6	83.5	111.	172.	241.	316.	396	480	669.	846.	1070.	1260.	1480.	374.
Square	0.096	0.207	0.621	1.34	2.45	3.94	7.19	11.7	24.7	45.0	72.3	109.	154.	277	444.	668.	949.	1290.	1680.
Round	0.076	0.163	0.487	1.05	1.93	3.10	5.64	9.18	19.4	35.4	56.7	85.5	121.	218.	348.	526.	746.	1010.	1320.

Table II. Values of B, Multiplier for Other Pressures and Temperatures

B_v to be used with Volume Figures in Table I
B_w to be used with Weight Figures in Table I

Temp. Deg. F		Barometer (Elevation above Sea Level) 30" Hg (-72')	27" Hg (2820')	24" Hg (5980')
-100	B_v	0.86	0.90	0.95
	B_w	1.20	1.14	1.07
0	B_v	0.95	1.00	1.06
	B_w	1.06	1.00	0.94
100	B_v	1.02	1.07	1.13
	B_w	0.97	0.91	0.86
200	B_v	1.09	1.15	1.21
	B_w	0.88	0.83	0.78
300	B_v	1.16	1.22	1.29
	B_w	0.81	0.77	0.74
400	B_v	1.22	1.28	1.36
	B_w	0.75	0.71	0.67
500	B_v	1.28	1.34	1.42
	B_w	0.71	0.67	0.63
600	B_v	1.34	1.40	1.48
	B_w	0.67	0.63	0.59
700	B_v	1.38	1.45	1.53
	B_w	0.63	0.60	0.56
800	B_v	1.43	1.50	1.58
	B_w	0.60	0.57	0.53
900	B_v	1.47	1.54	1.63
	B_w	0.58	0.54	0.51
1000	B_v	1.50	1.57	1.67
	B_w	0.56	0.53	0.50

Table III. Values of C, Multiplier for Pressure Drop per 100 Lin Ft

C for various △ p's
For either volume or weight

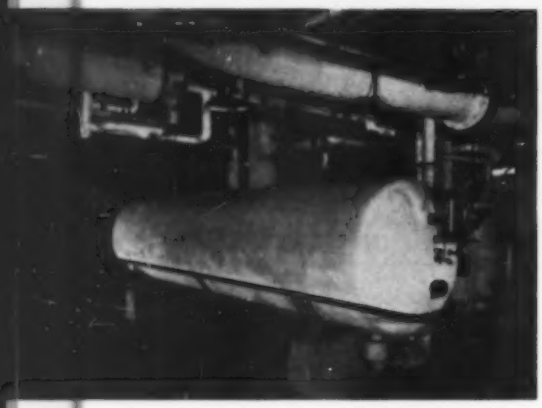
△ p	C	△ p = ↓ + → 0.00	0.05
0.00	0.00	0.1	1.00	1.23
0.01	0.29	0.2	1.43	1.61
0.02	0.42	0.3	1.77	1.92
0.03	0.52	0.4	2.06	2.19
0.04	0.61	0.5	2.31	2.43
0.05	0.70	0.6	2.54	2.65
0.06	0.77	0.7	2.75	2.85
0.07	0.83	0.8	2.95	3.04
0.08	0.89	0.9	3.13	3.21
0.09	0.94	1.0	3.29	3.37

△ p for various C's

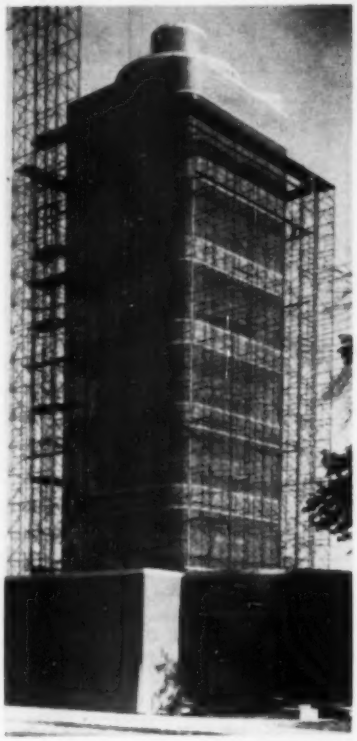
C = ↓ + →	0.	1	2	3
0.0	0.000	0.100	0.381	0.831
0.1	0.0014	0.120	0.417	0.886
0.2	0.0050	0.142	0.456	0.943
0.3	0.0105	0.165	0.497	1.001
0.4	0.0179	0.190	0.539	
0.5	0.0271	0.219	0.586	
0.6	0.0381	0.248	0.629	
0.7	0.0509	0.279	0.677	
0.8	0.0655	0.311	0.726	
0.9	0.0819	0.345	0.778	

Power Engineering

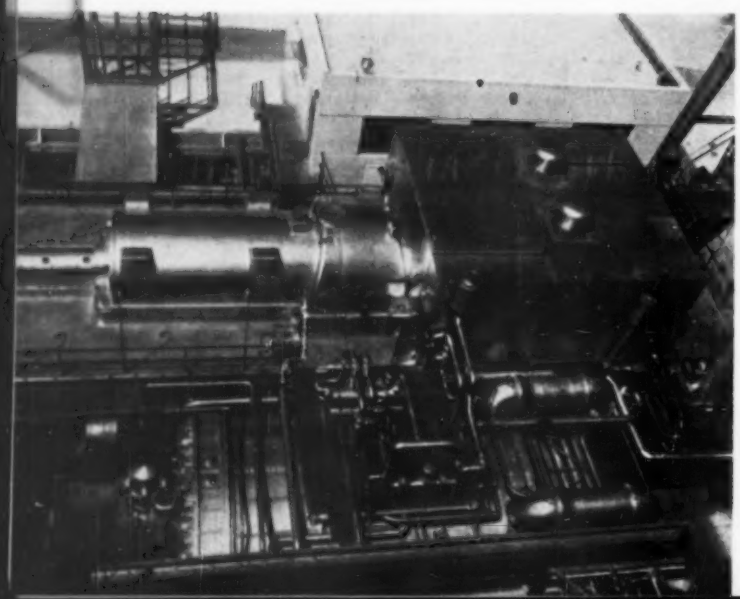
Two Titusville boilers at Oklahoma City University installed with the new Multi-Rib setting developed by Plibrico and with Plibrico sectionally-supported insulated furnace linings. The refractory lining can be anchored to and sectionally supported from the casing, if desired, transferring lining load to casing. New setting designed to permit lighter, stronger and more economical construction, good appearance



Recent installation of Ruths accumulator with all necessary control equipment, made by Foster Wheeler Corp. at large tobacco company plant. In preparing tobacco for process, very high demand for steam occurs for short periods in a moistening chamber; no steam required in chamber for long periods. To allow power plant boilers to generate at uniform rate, this accumulator was installed. It can store 900 lb of steam charged at 125 psi and discharged at 15 psi at 90 per cent filling. Discharge rate about 6000 lb per hr



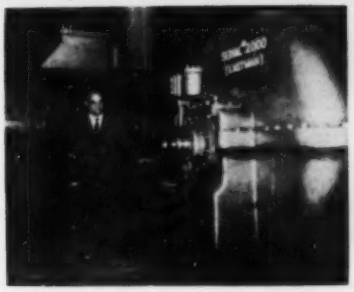
This unique structure is a 15-story glass-and-brick research tower, designed by Frank Lloyd Wright, under construction for S. C. Johnson & Son, Inc., at Racine, Wisc. It has an inner core of concrete, and cantilevered floor levels inside double walls of glass



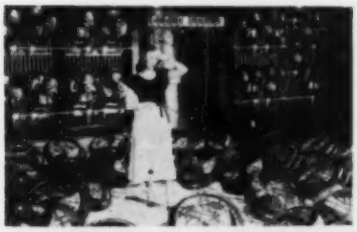
Health officials inspecting equipment inside Pennsylvania's new mobile air pollution laboratory, built by Mine Safety Appliances Co., for investigating air contamination

Left—Inverted-bowl type 37,500-sq-ft Foster-Wheeler surface condenser is a feature of the outdoor turbine-generator installation at Cutler Station of Florida Power & Light Co., Perrine, Fla., designed by Ebasco Services. Condenser is in foreground, alongside 60,000-kw turbine generator

NEWS REEL



Dr. Willis H. Carrier, inventor of centrifugal refrigeration machine in 1921, is shown with 2000th such unit produced by Carrier Corp. This unit, designed to produce —85 F temperature, is for Eastman Kodak Co.



No, these are not midgets—they are full-size workmen assembling a 20-ft-high, 3,500,000 kva compressed air circuit breaker being built by Westinghouse for Consolidated Edison of New York

Surge of energy more than 2½ times as great as the rate at which entire Northwest power pool can supply power to its customers was produced at Grand Coulee dam recently to test the world's largest 10,000,000-kva circuit breakers

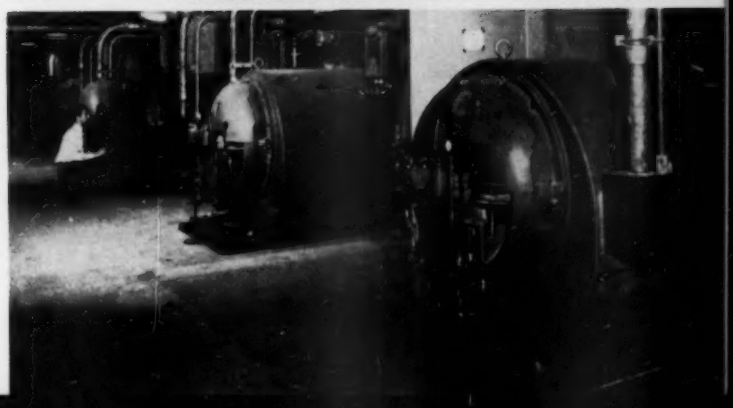
←

Left—Helen Powers envies this GE power transformer (in background) which has 108 fans to help it beat the summer heat. They blow 5400 cfs of air against it

→

Right—Wearing an air-force style flying suit, Wilson Gingerich speaks into microphone in large cold room where Caterpillar Diesel engines are tested at temperatures as low as –65 F

Below—Six of the nine 1000-hp GE motors installed for boiler feed pump drive at the Harbor Steam Plant at Los Angeles Department of Water and Power, Wilmington, Calif.



G-E

Fig. 1. The new home of the General Electric Research Laboratory located at the Knolls near Schenectady, N. Y. Five stories high (two stories below ground) it houses 107 laboratory rooms, an auditorium, a penthouse for executive offices, and shop areas

RESEARCH is a magic word. It suggests the thrill of exploration, the power of new knowledge, and the manifold benefits that accrue from a fuller understanding of nature. Fundamentally, research is the lamp of progress. Most of the arts and sciences owe their present stature and hope of future development to the revealing light of research. Modern industry derives its very lifeblood from research and our national security depends upon it.

Yet, only a few decades ago, research was confined to the comparative seclusion of university laboratories. The first industrially-sponsored laboratory in America dedicated to fundamental research was established by the General Electric Co. in 1900, just fifty years ago. That first home of the G-E research laboratory was an exceedingly humble one—a barn back of Dr. Steinmetz's Residence. Dr. Steinmetz, indeed, was one of the promotors of the idea. He, together with A. G. Davis, manager of the Patent Department, conferred with E. W. Rice, Jr., who was then technical director of the company. The proposal met with a hearty reception and immediate steps were taken to make the plan a reality. The first move was to find a man to organize the laboratory and to direct its activities. This man, they found in Dr. Willis R. Whitney, then a young chemist at MIT. He was hesitant to accept the offer because he feared that industrial research would not provide the range of interests and freedom for investigation that made academic research so attractive to him. Mr. Rice reassured him as to the rewards of industrial research in the form of scientific achievement and so far as his own interests were concerned told young Whitney to write his own ticket. Thus, there was established the principle of individual initiative that characterizes the work of the laboratory to this day.

Thus, in Steinmetz's barn Willis Whitney established himself and set about surveying the electrical field for unsolved problems that might appeal to his boundless curiosity. He found plenty of them—enough to provide stimulation and excitement for a long and fruitful career. In that pioneer laboratory there was inaugurated a research program that has grown with the years until its impact is now felt in every American home.

Soon, after the laboratory was established, the barn was destroyed by fire, and in the spring of 1901 the laboratory was transferred to a small building in the Schenectady Works. This was the first of a number of moves that came with the growth of the Laboratory, culminating in the new 18 million dollar laboratory formally dedicated on October 9.

Details of Design

This great new laboratory has been in the making since January 1945, when the project of co-ordinating the planning for new buildings and facilities began. The job was first to ascertain requirements in terms of types and quantities of services and structures needed, and then to help convert plans and new ideas into the buildings which the staff began to occupy this autumn.

The choice of the site, an estate called "The Knolls," about 5 miles from the Schenectady Works was based upon a number of factors of which the natural beauty of the site was perhaps least important. The Mohawk River on which the Laboratory is located can provide practically unlimited quantities of cooling and process water; also it furnishes means for disposing of liquid wastes after they have been properly neutralized and purified. The River furthermore permits barge transportation for fuel oil or for bulky or heavy equipment. It is close to good residential areas and has a branch line of the New York Central Railroad running through the site.

The largest item in a research laboratory budget is pay for the researchers' time. Consequently a large capital investment in specialized buildings is justified if it provides convenient services to make experimentation easier and faster. Therefore, the main building is so designed that in any room there is available any or all of the following services: hot and cold water, distilled water, laboratory drain, hydrogen, nitrogen, oxygen, city gas, compressed air—high and low pressure, rough vacuum, and 125 lb steam. Furthermore, experience teaches that the level of demand for electric service for experimental work is continually increasing so that the following electric services are available in any room: 120/208-volt, 3-phase, 4-wire, 60-cycle power; 265/440-volt, 3-phase, 4-wire, 60-cycle power; and 125/250-volt direct current.

An important part of the laboratory are the shops where special experimental tools and apparatus are made. While certain known items of equipment can be purchased as stock items, innumerable special tools and gadgets become necessary and these are more quickly made in the laboratory's own shops. These are located on the lower floors of the buildings. Here

Dedicates a LABORATORY

General Electric celebrated the 50th anniversary of the nation's first industrial research laboratory by the formal dedication of the G-E Laboratory's new home at the Knolls near Schenectady, on October 9. This new laboratory which has been built during the last few years at a cost of 18 million dollars is, without doubt, the most complete and finest laboratory in the world

the scientists can have the invaluable aid of good craftsmen either in "hay-wiring" together a "quick and dirty" gadget if that is all that is desired or in designing and constructing apparatus of considerable complexity. These shops are as nearly as possible in the physical center of the research space.

As already mentioned the site was not chosen primarily for its natural beauty but it is one of unusual charm. As the visitor approaches the main building he is impressed by the avenue of fine old trees leading to the main entrance. These trees were planted by a former owner of the property and have been left undisturbed. Nearing the entrance, one can look into and even through the lobby, for the near and far walls are entirely of glass panels.

The building has roughly the shape of the letter T, the upright part forming the first wing of the building, which was completed in the autumn of 1948. The cross wing was completed during the past summer and is now fully occupied by members of the laboratory staff.

The lobby is 32 ft wide and 60 ft deep. Through the glazed wall, one obtains a magnificent view of the Mohawk River with the Adirondack Mountains in the distance. At the left of the lobby is an auditorium, seating over 300 persons, fully equipped with modern protection equipment. The back of the stage is normally closed by two large panels of light wood, but these can be rolled back by a motor to expose the projection screen.

On the floor below the auditorium, at ground level because the building is on a ridge, is the cafeteria. From this one can go out to a terrace, and thence to the gardens.

To the right of the reception room one enters a corridor to one of the laboratory floors. Most of this floor, at the entrance level, but which is known as the third floor, is devoted to the Metallurgy Division. This floor also has on it the library, where a scientist about to embark on a new research may look up in books or technical journals earlier work which may have a bearing on his problem.

The central wing of the fourth floor is devoted to electronics research, including the development of high-power tubes for the production

Fig. 2. Thresholds to science and some of the scientists who have crossed them. Right, front to rear: Dr. Willis R. Whitney, founder and first director of the laboratory; Dr. Albert W. Hull, inventor of the magnetron and other electron tubes; and Dr. Saul Dushman, expert on high vacuum. Left, front to rear: Dr. Vincent J. Schaefer and Dr. Bernard Vonnegut, who with Dr. Irving Langmuir are famed for discovery of methods of producing snow and rain from clouds; Dr. James Cobine, expert on high frequency tubes; and Dr. Katherine B. Blodgett, known for her work on invisible films

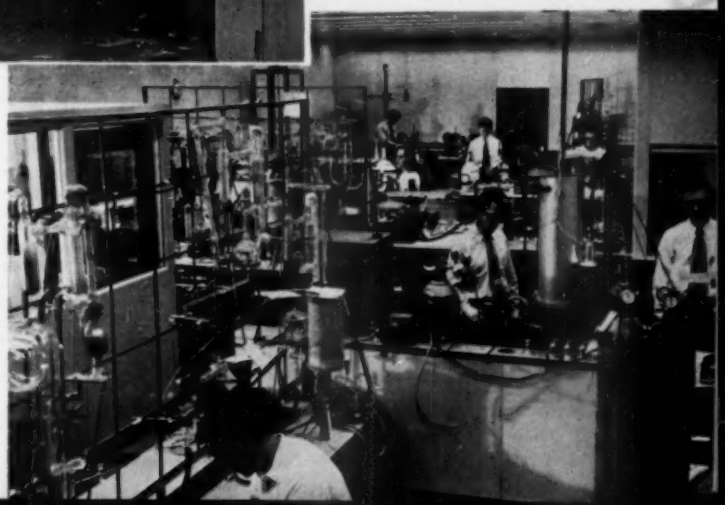


Fig. 3. Typical laboratory room in the new laboratory. Part of the Metallurgy Division, this room is devoted to the investigation of the properties of metals

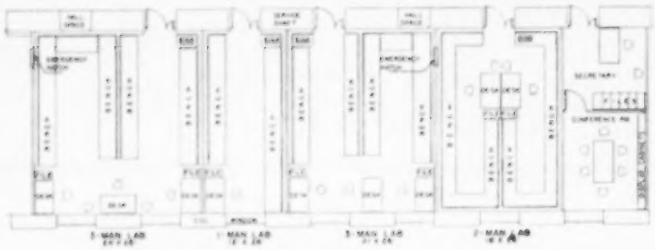


Fig. 4. Typical physics and electronics room arrangement

of short radio waves. Other electronic research, much of it concerned with television, is conducted on the fifth floor of the central wing. The fourth and fifth floors of the cross wing house the Chemistry Division.

On the second floor of the building, there are research rooms for the division of mechanical investigations, devoted to the studies of rockets, combustion, refrigeration, vibration, etc.

In addition to the main laboratory building, there are a number of others on the 180-acre tract. To the East is the Radiation Laboratory, in which a new type of accelerator known as the non-ferromagnetic synchrotron is installed. This apparatus, which is expected to yield 300,000,000-v x-rays is nearing completion. This building also houses an 80,000,000-v synchrotron, and x-ray equipment for one, two and ten-million volt radiation.

Early in the planning of the new laboratory it was necessary to decide whether a building with windows was desired or one without windows. A building without windows could be built cheaper than one with windows but a canvass of the technical employees indicated that many would not want to work continuously in a windowless building. Hence, a building with windows was built.

The exterior pilasters are made 6½ ft wide so as to allow three possible partitions, the preferred one at the center or if desired 3 ft either side of that point. This makes possible rooms having widths which are multiples of 3 ft. Room widths which are multiples of 12 ft are repetitive; the others can be arranged only in certain specific sequences.

Laboratory doors open outward from the rooms into the corridors for ease of egress. Each 4-ft wide doorway has a 1-ft-wide hinged panel which is normally bolted closed and a 3-ft-wide active leaf opening into a vestibule between service shafts. The arrangement is shown in Fig. 4. This door has a clear glass panel to provide visibility. Also, the door, when open, does not protrude into the corridor.

In general, two means of egress have been provided from each laboratory room in which hazardous work may be done. If the room is so small that it is not convenient to have two doors, escape hatches into an adjoining room have been provided at the end of the room far from the door.

For fire fighting, portable 3-, 5-, or 10-lb CO_2 hand extinguishers are provided, at least one in each room. In addition at each stairwell on each floor 50-lb CO_2 carts are located in cabinets off the corridor. The experience of the laboratory staff is that all but extremely unusual fires can be put out quickly with hand CO_2 extinguishers.

In standard research space thermostatic-type fire detectors have been installed on the ceilings with zoned drop-type indicators in the electrical control room where an operator will be stationed at all times. Basement and shop areas are protected with standard water sprinklers.

(3) All electrical and pipe services can be turned off in the shafts where they take off from the vertical feeders. Thus in the event of trouble in any room the services to the room can be turned off from the corridor without entering the room.

(4) For many years safety committees have been urging the use of solid protective grounds in addition to normal neutral wires on all electric systems. For example, single-phase lines would use three-prong plugs and sockets with the third or protective ground wire providing a means for connecting machine frames or equipment chassis solidly to ground independent of the electrical neutral or of the metal conduit whose continuity might be imperfect. Likewise, three-phase plugs without neutral would be four-prong so as to carry the protective ground wire. Furthermore, four-wire three-phase circuits in which the neutral is also carried through so that line-to-neutral voltage is available would require a fifth wire for the independent protective ground.

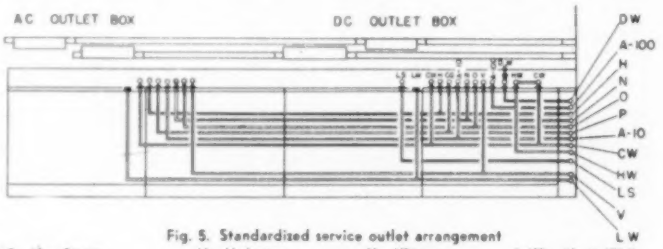


Fig. 5. Standardized service outlet arrangement

LS: Live Steam
LW: Laboratory Waste
CW: Cold Water
H: Hydrogen
CG: City Gas
A-10: Air at 10 lb
N: Nitrogen
O: Oxygen
V: Vacuum
A-100: Air at 100 lb
DW: Distilled Water
HW: Hot Water

Dedication

The dedication of this great new laboratory was attended by leaders in science and industry from all parts of the country and by some from other countries. Honored guests at the ceremonies included Dr. Willis R. Whitney, founder of the laboratory in October 1900, and its first director, and Dr. William D. Coolidge, x-ray pioneer and director emeritus. Now 82, an honorary vice president of General Electric, Dr. Whitney is still active in research.

Also in attendance were the members of the National Academy of Sciences, holding its autumn meeting at the laboratory. In the principal address, Charles E. Wilson, President of General Electric, reviewed the accomplishments of the laboratory in the past half century, and cited the necessity of industrial research to the nation's economy. Following his speech, Mr. Wilson formally dedicated the new home of the laboratory to the advancement of scientific knowledge and presented golden keys to Dr. C. G. Suits, G-E vice president and director of research.

In his acknowledgment, Dr. Suits paid tribute to Mr. Wilson's continued interest in the Research Laboratory and then unveiled a bronze plaque, at the entrance of the main building, which expresses the appreciation of the people of the Research Laboratory to the company president. Dr. Suits also unveiled two heroic glass portraits of Dr. Whitney and Dr. Coolidge. These are panels, each 33 by 57 in., set into the glass wall which forms the front of the entrance lobby to the main building. They were made by a new process developed by the Corning Glass Works in which the photographic image is formed through the glass itself.

Fig. 1. The 4-cycle, 6-cylinder, supercharged Nordberg Dual-fuel Diesel installed at the Elkhorn Municipal Plant. It drives an 875-kw, 2400/4160-v Elliott Co. generator

Gas Burning Diesel

Cuts Power Cost 50 Per Cent

By A. J. WOLFF
Plant Superintendent, Elkhorn Municipal Power Plant
Elkhorn, Wisconsin

THE PURCHASE OF a dual-fuel Diesel engine by the Elkhorn Light & Water Comm. of the city of Elkhorn, Elkhorn, Wisconsin, in 1948 was an innovation in the municipal power field. To some it may seem unusual to use natural gas as the main fuel supply with the source hundreds of miles away. Wisconsin is not generally looked upon as a field for Diesel engines of the larger sizes arranged for gas burning yet here at Elkhorn is evidence that an engine of this type has definite advantages. It is believed that this is the only gas burning Diesel in service in Wisconsin.

When the power plant building was originally constructed it was the intention to install Diesel generating equipment but this plan failed to materialize. At that time the city maintained a distributing system but purchased its power requirements from a utility system. Until the present Diesel was installed, the building housed the distributing switchboard, two motor driven pumps of the city water system, a single cylinder 50 hp variable speed Diesel belted to a centrifugal pump which served as stand-by, a work shop and garage space. In 1940, a plan was again considered to install three 900 hp Diesels to take over the entire city load, but this also was never carried through.

When natural gas became available in Elkhorn, consideration was given to the installation of a Diesel that not only would burn this low cost fuel but would also burn oil fuel should there be times when gas was not available. This led to the purchase of a Nordberg Duafuel engine in March 1948. This engine is a 4-cycle, 6-cylinder supercharged unit with a 16 in. bore and 22 in. stroke and drives an 875 kw, 2400/4160 v, 3 phase, 60 cycle Elliott generator with 15 kw, v-belt driven exciter. Being of the dual fuel type it operates as a Diesel on either gas or oil fuel. The change from one to the other can be made instantly by rotating the control wheel at the end of the engine. Normally the engine burns gas but the contract with the gas company is such, that during periods of extreme cold weather when there is a shortage of gas, it may be necessary to switch the engine to oil fuel. The plant is given about an hour notice when a changeover is required. During the winter of 1949-1950 the total time that the engine was off the gas line was only 20 hr, the longest single period being 6 hr.

Shortly after the engine was purchased there was a change in the supervision of the plant and when the present superintendent took over, the generator had been delivered and was setting outside the plant, while the engine stood on a railroad siding awaiting to be unloaded. Some work had been started on the foundation. There had been no complete plant layout made, no auxiliaries had been ordered; in fact the whole project was at a standstill. After gathering all the loose ends and overcoming difficulties and delays in securing materials and services, the installation was finally completed and the engine placed in service late in July, 1949.

Since the engine did not have sufficient capacity to carry the entire city load, it was intended to operate it in parallel with the Wisconsin Gas and Electric Co. system. This would accomplish two purposes. One, it would smooth out the peaks of the city service, thereby lowering the demand charge and reducing the over-all rate of purchased power. Two, it would provide some standby service in case of a failure of high line service. The engine is held at practically full load capacity with unit power factor from 7 am to 10 pm six days a week. During this period, only the demand in excess of the load carried on the engine is supplied by the utility system which also carries all the city load when the engine is not in service.

Table I for the first four months of 1950 shows the comparative costs of gas burning Diesel generated power with purchased power. Since the engine operates on constant load, there is little difference from month to month of the various expense items that enter into the cost of generation.

The figures show that the engine is delivering a kilowatt hour for 9.77 cu ft of natural gas and has a lube oil consumption of 4301 kwh per gallon. Including cost items of gas,

pilot and fuel oil, lube oil, labor and maintenance, the kilowatt hour cost is 0.603 cents as compared with 1.25 cents for purchased power. During this period, the only expense for maintenance was the renewal of filter elements of the oil purifier which are replaced periodically. During these four months, the engine operated for a total of 1537 hr, which with the 1,354,922 kwh generated shows the engine was carrying an average load of 881 kw. This means that the engine was slightly beyond its full load rating of 875 kw.

For the month of March it will be noted that the amount of pilot and fuel oil was much higher than for either of the other three months. This was occasioned by cold weather when the engine had to go from gas to oil fuel on several instances.

The plant is favorably located adjacent to the main of the Wisconsin Southern Gas Co. A 4-inch line carrying gas at 50-55 lb pressure goes to the gas company's regulators, where the pressure is reduced to about 14 lb. After passing through two American Gas meters arranged in parallel, the gas is again piped outside the building to a scrubber which also serves as a combined reservoir and surge tank.

Oil used for pilot fuel and for regular operation when gas is not available is delivered by tank car to a siding which runs through the rear of the plant property. There are two storage tanks having capacities of 15,300 and 27,500 gal with unloading facilities consisting of a Viking Type ZL transfer pump driven by a 3 hp Master motor.

Oil from the storage tanks flows by gravity through a Trident filter, a Trident meter and then to the built-in fuel transfer pump on the engine which delivers oil to the fuel header. There is also an overhead day tank of 300 gal capacity to which fuel can be transferred by a Roper 3 gpm, 40 psi pump driven by a $\frac{1}{4}$ hp General Electric motor and which is located in the pit adjacent to the engine.

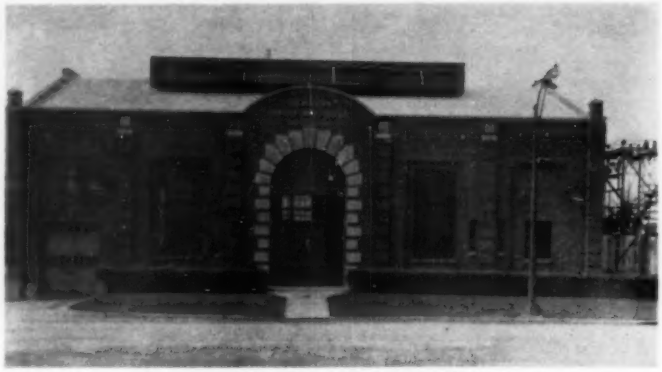


Fig. 2. The Elkhorn light plant at Elkhorn, Wisconsin

With the small amount of oil fuel used as pilot fuel when the engine is burning gas and since the engine burns oil only on rare occasions during winter, it has been found advisable to use a quality fuel oil. For this purpose, Lockwood's lubricated Diesel oil, a clear, light weight oil, is being used. While the cost is but little more than fuels normally used for an engine of this type, the advantages more than outweigh any difference in cost, especially since so little oil fuel is used. The higher cost would have little effect on the over-all cost of power generation.

The cylinders are lubricated by a 12 feed Manzel force feed lubricator mounted at the control end of the engine. Bearings and other details requiring lubrication are cared for by the circulating pressure system and supplied from a built-in gear driven pump located on the operating side of the engine adjacent to the flywheel. Oil from the various parts lubricated returns to the sump in the bedplate. The pump takes its suction from the sump and forces the oil through a Nordberg duplex strainer, then the Ross lube oil cooler having a capacity of 550,000 btu per hr and then to the lube oil header on the engine for recirculation. A Hilco purifier operates continuously, taking oil from the sump, and after being purified the oil is again returned to the sump supply. This purifier has a capacity of about 2 gpm.

There is also an auxiliary lube oil pump to serve as an emergency should there be a failure of the built-in pump and is also used as a before and after lubricating pump. This is a Roper rotary pump having 130 gpm capacity at 50 psi and driven by a 10 hp General Electric motor.

One noticeable advantage in the use of gas fuel is the lack of contamination and the long life of the lubricating oil. After the engine had seen 2175 hr of operation, a sample of the oil which is Ursa P-30, was sent back to the Texas Co. for analysis. It was found that there had been no change in the oil since the engine was placed in service other than a minor difference in viscosity which could readily be remedied. With the method used for purification it is believed that the oil will last indefinitely. Over a four month operating period, the engine showed a lube oil consumption of 4301 kw hours per gal. While this good showing in lube oil consumption has a

Fig. 3. The Hilco oil purifier and Gardner-Denver starting air compressor

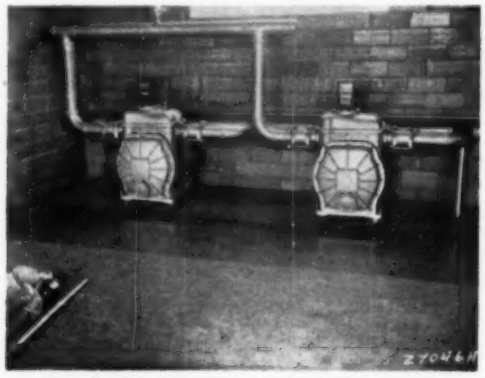


Fig. 4. Parallel arrangement of the American gas meters

TABLE I

MONTH ENG. HRS.	K.W. HR. GENERATED	GAS CU. FT.	COST OF GAS	PILOT FUEL OIL GALS.	FUEL OIL COST
JAN 363	325,940	3,214,000	$1,392.40	772	$ 84.92
FEB 391	344,600	3,465 000	1,463.70	903	99.33
MAR 392	345,442	3,207,000	1,390.30	2.751	302.61
APR 391	328,940	3,375,000	1,394.80	929	102.19
1537	1,354,922	13.261,000	$5,741.20	5,355	$589.05

LUBE OIL GAL.	LUBE OIL COST	LABOR	MAINTE-NANCE	K.W. HRS. PURCHASED	COST OF PURCH. POWER	MONTH ENG. HRS.
72	$ 38.88	$ 410.00		429,600	$ 5,370.00	JAN 363
72	38.88	410.00	$40.00	439,200	5,270.40	FEB 391
91	49.14	410.00		360.000	4,608.00	MAR 392
80	43.20	410.00		355,200	4,511.04	APR 391
315	$170.10	$1,640.00	$40.00	1,584,000	$19,759.44	1,537

definite bearing on kilowatt hours production cost, it has a further advantage that cannot be so readily noted. This is the minimizing of wear to bearings and working parts attributed to clean oil. Lessened wear means lower maintenance expense and longer engine life.

Water for Elkhorn is obtained from deep wells which is also the source of cooling water supply for the engine. Raw water is taken from one of the wells and is discharged into a 275-gal tank located just above the floor and back of the engine. At the outlet of this tank is a Y connector, one branch going to the lube oil cooler, the other to the Allis-Chalmers Electrifugal raw water pump of 300 gpm capacity at 90 ft head and driven by a 15 hp motor. This pump discharges through a Ross heat exchanger which has a capacity of 1,710,000 btu per hr. After passing through the heat exchanger, the water is carried to an old well and returned to the ground supply. All city water is treated and consequently soft water is available for the engine jackets. This water is circulated by an Allis-Chalmers Electrifugal pump of 300 gpm capacity at 70 ft head and driven by a 10 hp motor. In this circuit is an overhead surge tank of 50 gal capacity.

The plant at Elkhorn is exceptionally quiet in operation due to effective silencing. A concrete structure houses the American air filter on the suction line, while a Burgess-Manning snubber quiets the exhaust. On the exhaust line is a Zallea flexible connector to care for expansion.

A panel on the operating end of the engine has the push button controls for the auxiliaries, and a Viking alarm for lube oil and jacket water pressures and temperatures. This alarm functions should the oil or water pressure drop below 15 psi and the temperature of either rise above 150 F.

Air for starting is supplied by a 11cfm, 250 psi Gardner-Denver air compressor with 5 hp motor.

While the Diesel engine generates less than half of the city's requirements, the savings being made definitely prove that the installation is a good investment and that greater savings would be possible if the entire city load could be carried by Diesel engines. As changes and improvements are being made, all are a part of a long range plan of a future expansion program of the city's utilities.

Civic Responsibility of Engineers to be Theme of 1950 ASME Annual Meeting

THE AMERICAN SOCIETY of Mechanical Engineers will hold its 1950 annual meeting at the Hotel Statler, New York City, November 26 to December 1. It is scarcely necessary to point out that the various technical phases of mechanical engineering will be covered by a full program, bringing out important developments in research, design, operation and management in all parts of an ever-expanding field. However, it is becoming increasingly apparent that the engineer must devote more and more of his attention to his responsibilities as a citizen and an individual in the modern world. Therefore, there has been increasing tendency during the past few years to place more and more emphasis on these interests at the Society's annual meetings. Also, there has been a growing awareness that much needs to be done to integrate junior members more firmly into both the activities of the Society and into their positions in the field. Hence the interest in the theme of the meeting, which will be discussed right at the beginning by A. W. Robertson, Chairman of the Board of Westinghouse Electric Corp., at the President's Luncheon on Monday, November 27.

This year, too, the 19th Exposition of Power and Mechanical Engineering to be held at Grand Central Palace simultaneously with the ASME Meeting, is being more actively sponsored by the Society this year. This exposition, popularly known as the Power Show, is previewed elsewhere in this issue.

While the tentative program is still being formed at this writing, the general subjects listed below are being scheduled for discussion at the technical sessions.

Boiler Feedwater:—Simplified Apparatus for Determining Dissolvable Solids in Steam by Electrical Conductivity; Prevention of Embrittlement Cracking; Solubility of Quartz and Some Other Substances in Superheated Steam at High Pressures.

Education:—The ECPD—What It Is and What It Does.

Furnace Performance Factors: — Furnace Heat Absorption in Pulverized Coal Fired Steam Generator, Willow Island Station.

Heat Transfer: — Various Discussions of Stresses in Heat Exchanger Tubes and Expansion Joints; Effective Mechanical Design on Life of Tubes in Heat Exchangers; Aluminum Alloys in Heat Exchanger Construction; Leak Proof Heat Exchanger; The Mechanism of Boiling Heat Transfer; Expanded Tube Joints; Precise Temperature Measurements, etc.

Hydraulics:—Possibility of Balanced Flow in Compressor and Turbine Blading; Influence of Reynolds Number on Performance of Turbo Machinery; Performance of Pump Impellers; Investigation of Flow Through Screens; Round Table Discussion of Cavitation.

Industrial Instruments and Regulators:—Precision and Accuracy of Orifice Meter Installations; Controller Settings for Optimum Control; Improved Pneumatic Control System; Venturi Flow Element; Development of a High Dynamic Performance Hydraulic Servo.

Power:—Pinions and Gears for Marine Propulsion Plants; The Engineering of a 30,500 Super Tanker, The first Ship Using 1020 F Steam; Intake Tunnel Design for Condenser Circulating Pumps; Fireside Deposits of Steam Generators Minimized Through Humidification of Combustion Air; Resuperheating in Steam Turbine Plants; High Temperature Properties and Characteristics of a Ferritic Steam Piping; Report on Split Steam Lead at New Orleans; Stress and Deflection Tests of Steam Turbine Diaphragm.

For junior members who have recently entered the ranks of ASME corporate membership, the Junior Conference on the topic "How is Your PD (Professional Development)?" should be an interesting experience.

The Oakley "Colony" Power House

Central power house serves 7 industrial plants with steam, d-c power and other services in Oakley District of Cincinnati, Ohio . . . Plant has total steam capacity of 300,000 lb per hr in five underfeed-stoker-fired boilers . . . Cincinnati Milling Machine Co. requires about 80% of plant services, which include supplying building heating steam, hot water, compressed air, direct current, drinking water and fire-fighting water . . . Old Corliss engines soon to be removed

By H. B. McDERMID

Fig. 1. General view of Oakley "Colony" Power House

FIFTY YEARS AGO, the machinist's apprentice, if he had an inquiring mind, and especially if his shop was located in the Middle West, was apt to find the name of Cincinnati, Ohio, cast on the frame of nearly every machine tool he was learning to operate—lathe, milling machine drill press, or planer, until it seemed to him as if all the machine tools in the world must be built in that city. About that same time, The Cincinnati Milling Machine Co., after some 25 years of adversity in bad locations for expansion, a devastating fire, and a never-ending struggle in those early days for adequate recognition of an excellent product, decided to settle in its present location, in a section known as the Oakley district of Cincinnati.

Why A Central Power Plant For Group

About this same time, other machine tool manufacturing shops located near by, and a "Colony" power house for all came into being, to furnish all necessary services for the group of plants, the cost of the plant and its services to be distributed in proportion to its usage by each company. The idea has worked out successfully; the power house, Fig. 1, is still going strong, with constant study being made for all possible improvements and further extensions of services.

About the time of this power plant's inception, the idea of driving machine tools by belts from line shafts was on its way out, and the day of individual motor drives was coming in. So the earlier prime movers installed here were the tandem-compound steam piston engines, with Corliss valve gear, driving direct-current generators, mounted on the engine main shafts. These machines were the finest of their day, especially for their service, for most engineers then were convinced that machine tools could not be satisfactorily motor-driven except with direct-current motors, on account of the many speed changes desired. These prime movers are still available for service, though their day is over and they are slated for removal in the near future.

How A-C and D-C Power Are Obtained

With the adaptation of alternating-current motors and machine tools to each other, the motor drive picture has changed until 90 per cent of the electric power now going through this power house is alternating current. The 10 per cent of direct current is obtained by passing the required amount of alternating current through rotary converters; direct current is not now generated in the power house, except a small

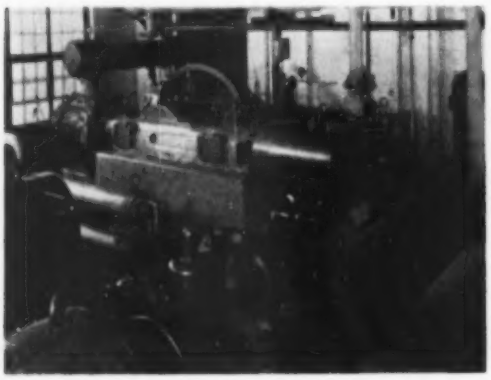


Fig. 2. One of the steam-driven air compressors, which supply exhaust steam to heating system in winter

Fig. 3. One of the multiple-retort underfeed stokers firing one of the 5 boilers in Colony Power House

amount for "house" use. Constant study of conditions has convinced the company that alternating current can better be bought than generated, so all the alternating current comes from the giant generating stations of the local public utility, which are located on the river bank where the enormous quantities of necessary condensing water can be gotten readily and cheaply—a situation which cannot be duplicated high up on the hills where such water conditions do not exist.

Heating and Other Services

But there still remain the heating services, the compressed air supplies, the fire protection and industrial water supplies, the drinking water systems, air conditioning, and so on, to be supplied to each of the seven manufacturing plants, as their needs may indicate. Of these services, the "Mill," as The Cincinnati Milling Machine Co. is popularly called, with its approximately 34 acres of floor space, requires about 80 per cent while the other six take the remainder. Steam for heating and compressed air requirements, as well as other services, is generated by a battery of five water tube boilers, two rated at 30,000 lb per hr each, one at 120,000 lb per hr, and two more at 60,000 lb per hr each. These furnish heat for the plants, some of which goes out in the form of hot water, but the vast majority in the form of low pressure steam. Some steam drives the air compressors (one of which is shown in Fig. 2) on its way out. In winter, the exhaust steam from the compressors is used for heat, while in summer, nearly enough capacity of air compressors is driven by direct-current synchronous motors to carry the entire load of normally around 5000 cfm. Constant study of the existing conditions indicates the desirability of adding another electrically-driven compressor for summer use and it seems probable that another such unit may be added soon to the group.

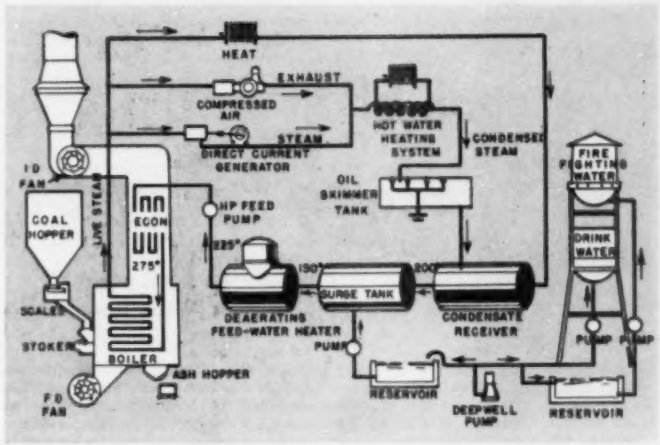


Fig. 5. Schematic diagram of steam and water connections, Colony Power House. All piping painted to a color code

Five Boilers Supply Steam

The boilers installed are of the most modern design, with particular care being taken to utilize every detail of modern instruments and accessories to aid clean and economical operation. All pertinent temperatures are recorded, all controls possible are carried out automatically, including the control of smoke and fly ash. Coal is brought in, in hopper dump gondolas, elevated to the top of the boiler house, distributed by means of the conveyor system to the storage bunkers, thence fed by gravity through the scales to the underfeed stoker hoppers, Fig. 3. From the stokers the ash is delivered by pneumatic conveyor to the top of the building again, there to be dumped into a tight storage hopper, from which they are dumped wet into highway dump trucks to be hauled away.

No effort is spared to obtain scientific engineering data on the performance of the plant, and that performance is constantly being studied at all times, with a view toward possible improvements of any kind.

Water Services

The water services of the plant are worthy of notice. Pumped from the company's own deep well at a constant year-around temperature of 55 F, the employees' drinking water service is handled by an independent system. Unusual is an elevated tank for this service, mounted on the same tower as that for the fire system, and just below it. Rarely does one see two tanks supported thus on a single tower, Fig. 4, though there is no reason, engineering or sanitary, why they should not be.

Although this plant does not produce alternating-current power, it does produce all other services this community of modern machine tool manufacturing plants can require, and does it cleanly, economically, and in a completely dependable manner. What more could any group of shops desire?

Fig. 4. Water for fire fighting stored in upper tank, drinking water in lower

Fig. 6. Portion of the boiler control panel. All boilers are under complete automatic combustion control, have good instrumentation

Protection of *Mercury Power Plants*

By R. M. ILFELD
Special Products Division, General Electric Co.

DURING 1949 two new mercury power plants went into operation. One of these was the topping unit at the Pittsfield Works of the General Electric Co. and the other the new Schiller Station of the Public Service Co. of New Hampshire at Portsmouth described in the March issue of POWER GENERATION, this year.

Like the preceding mercury power plants each of these new mercury vapor plants posed new problems in the detection of mercury vapor.

Instruments which check the operation of mercury-vapor power plants involve not only many instruments used in all steam plants but a number of additional instruments for the detection of mercury vapor. The temperature recording instruments measure the temperature of each of the tubes in the boiler by means of thermocouples and sound an alarm if overheating occurs. These devices are fairly straightforward in nature and will not concern us further here.

The detection equipment for the protection of mercury vapor in power plants continuously analyzes the flue gases coming from the system, and sounds an alarm if the mercury concentration becomes greater than a preset limit. If mercury vapor is detected in the flue gases, the source of the leakage must be discovered and the fault repaired before further damage is done. The detector is actually two separate mercury vapor detection systems, each having a different principle of operation. This assures continuous service, even if one detector becomes inoperative for any reason. Also, continuous "cross-check" of each detector by the other is possible by comparing the indicators.

Electronic Mercury Vapor Detection

It has long been known that ultraviolet light of a certain frequency is very strongly absorbed by mercury vapor. This is especially logical when it is remembered that this resonant radiation (2537 A) is generated by a mercury vapor type ultraviolet lamp. The electronic mercury vapor detector continuously measures the ultraviolet transmission of a sample of gas, indicating the presence of mercury vapor when the transmission falls below a preset limit.

Fig. 1. This is a laboratory type mercury vapor detector. These detectors have been available for a number of years. They are used as portable instruments for the protection of personnel in factories and laboratories where mercury is used

Laboratory type mercury vapor detectors have been available for quite a few years, using this principle. These small portable detectors are used to protect personnel in factories, shops, and laboratories where mercury may be used.

The electronic detector for power plants consists of a pair of stainless steel chambers having quartz windows. The ultraviolet light is passed through these chambers and allowed to illuminate phototubes placed at the ends. Fresh air is constantly passed through one of the chambers and flue gas is passed through the other. When mercury vapor is present in the flue gas, light will be absorbed in the sample chamber, reducing the illumination falling on the phototube. After suitable amplification, this difference in phototube illumination causes the round-chart recording instrument to deflect, indicating the presence of mercury vapor and recording it on the chart.

The electronic unit supplies the necessary power and control to operate the recorder, and to amplify the phototube output. The recorder will read zero on the chart when the light falling on each of the phototubes is equal.

Flowmeters measure the flow of air and flue gas to the chambers. The flow is maintained at 0.4 cu ft per min. Electrically operated valves, by-passed by manually operated valves, permit quick selection of either air or gas. All piping, valves, chambers, etc. are of stainless steel to resist the action of mercury.

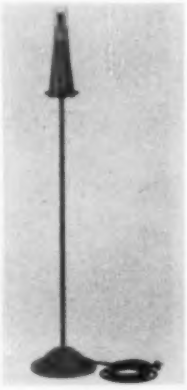


Fig. 2. A chemical type mercury vapor detector. This type is also used in laboratories for the protection of personnel

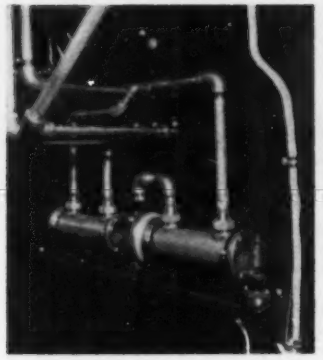


Fig. 3. Sample chamber assembly of mercury vapor detector

Mercury Vapor Detection by Chemical Means

Activated selenium sulfide will darken in the presence of even a very small quantity of mercury vapor. This principle has been used in laboratories in a mercury vapor detector for the protection of personnel. The same principle is applied to the detection of mercury in flue gas. A chart paper upon which selenium sulfide has been deposited is driven by a 24-hr clock. A stream of flue gas is directed against a small portion of this chart for 15 min, and the chart will darken if there is mercury vapor present in the gas. The amount of darkening is proportional to the concentration of mercury, and is measured by a phototube. Reflectance is decreased as the surface darkens and the phototube causes a relay to close and to sound an alarm when a desired chart color occurs. This alarm is adjusted to sound at the maximum allowable concentration of mercury vapor. The flow of flue gas is carefully adjusted to 0.4 cu ft per min.

Protection of the Boiler

Either mercury vapor detector will cause an alarm horn to sound whenever the mercury concentration exceeds the specified limit. The alarm point has been set in one case to 0.34 lb per hr, based on a flue gas flow of 330,000 lb per hr and a density of 0.033 lb per cu ft. This limit can be adjusted and may be altered, if found necessary. On the top of the mercury vapor detector panel are two lamps associated with the alarm, a green lamp which is lighted during normal operation, and a red lamp which will go on at the same time as the alarm horn sounds. The horn will continue to sound until the operator presses a button to stop it. The red lamp will remain lighted until another control is pressed. In the meantime, the power station operators will be able to locate and correct the trouble, effecting a shutdown if necessary. Rapid action of the detector and warning systems prevents serious losses of mercury, damage to the equipment, or hazard to the workers.

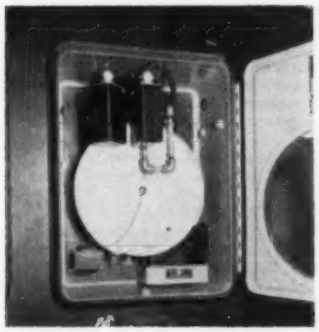


Fig. 4. Chemical type mercury vapor detector for power stations

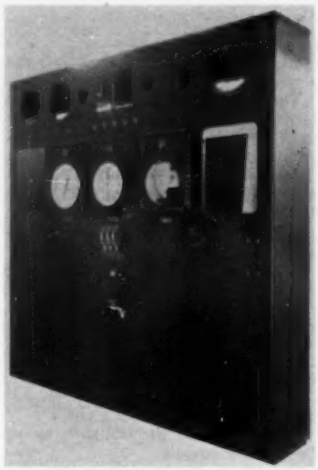


Fig. 5. Panel for mercury vapor detector

Sampling of Flue Gases

The flue gas sample is withdrawn from the flue by a small pump, then passed through a "water-washer" and filter before being piped to the detectors. Samples from several different points in the flue or from several different flues may be taken in succession if desired. Stainless steel materials are used in the pump, washer, filter and interconnecting piping. Fail-safe operation is provided by relays which sound an alarm and turn on a light if the sample pressure fails for any reason. Normally, the sampling system delivers flue gas to the detector at approximately 2 lb. pressure.

Every 4 to 8 hr, a periodic checkup is made by throwing approximately 1 cubic centimeter of liquid mercury into the boiler to simulate a mercury leak. The detector should sound its alarm, indicating that it has detected the mercury. By performing this check, the power station operators are assured that the mercury detection equipment is protecting the power plant.

Fig. 6. Electronic mercury vapor detector of another type for power stations

Summary

A mercury vapor detection panel consisting of two different types of detectors, an electronic detector and a chemical detector, has been installed in most of the mercury power plants built to date. The electronic detector measures the ultraviolet absorption of the flue gas, while the chemical detector exposes activated selenium sulfide to the flue gas. Alarm horns and lights warn the plant operators when a dangerous concentration of mercury vapor is present in the flue gas. A multipoint temperature recording system included with the mercury vapor detector keeps tabs on tube temperatures.

NEW POWER FOR AMERICA FILM

"New Power for America" is the title of a new 16-mm Kodachrome sound motion picture produced by Combustion Engineering — Superheater, Inc., New York. This picture tells the story of power in the postwar period. It first depicts the ever-increasing use of electrical energy in America's homes, farms and industries. It then traces the progress made in the science of power generation in the last three decades, and emphasizes the importance of this progress both in the economy of power production and the conservation of fuel. Finally, it portrays the vast postwar expansion program of our utility industry.

In illustrating the postwar growth of utility capacity, the over-all story is told graphically, and then exemplified by a series of scenes showing a number of new power stations in various stages of construction. These scenes are followed by the photographic chronicling of construction—from bare ground to finished project—of the Sewaren Station of the Public Service Electric and Gas Company of New Jersey.

The Economic Limit of *Capacitor*

The reduction of power factor is always a problem in industrial plants. If power factor is too high it can be reduced by the installation of capacitors or by the installation of more power equipment such as synchronous motors. In all such studies, however, it will be found that there is a definite transfer point, below which it is cheaper to install capacitors and above which it is cheaper to install power equipment. In this article Mr. Stangland shows how this transfer point can be expressed in terms of power factor and presents a nomogram for determining this transfer point quickly and easily—no figuring

By GLEN STANGLAND

WHEN a utility sells electric power, it is actually furnishing two kinds of current; first, the active current resulting in actual power; second, the magnetizing current necessary for operation of motors and other inductive loads. Magnetizing current is a "dead horse" that, while it results in no power delivered at the load, increases the investment in power equipment required to generate and distribute the total line current.

Together, the active current and the magnetizing current make up total line current. Power factor is the ratio of active current to total line current. The greater the proportion of magnetizing current, the lower the power factor. Since more power equipment is needed for low power factor systems, power factor improvement is of dollars-and-cents importance to the generating station engineer.

When generation station and distribution equipment becomes overloaded with low power factor loads, an obvious remedy is to buy more power equipment. Another and often cheaper remedy is to install capacitors near the load; the capacitors will furnish magnetizing current needed by the load, thereby improving power factor by reducing the total line current carried by the power equipment.

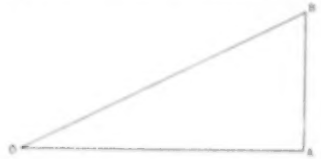


Fig. 1. The power triangle
OA = kw (kilowatts, Actual power)
OB = kva (kilovolt-amperes, Apparent power)
AB = kvar (kilovolt-amperes, reactive, Reactive power)
Pf (Power factor) = OA ÷ OB = Kw ÷ kva

The effectiveness of capacitors in raising power factor, in order to relieve overloaded equipment, decreases as the power factor is raised. When power factor is near its maximum value, capacitors have virtually no effect and the proper solution to the overload problem is to install power equipment.

Fig. 2. Power triangle
AB = kvar required by load
AB = kvar furnished by generating station

There is a transfer point, determined by the relative costs of capacitors and power equipment, before which it is cheaper to install capacitors, and beyond which it is cheaper to install power equipment. The transfer point can be expressed in terms of power factor, and the nomogram is used to solve for the transfer point when relative costs are known. How to use the nomogram will be shown later.

Industrial plants generating their own power should be as interested in the economics of capacitor application as are the utilities, since both sell power. The industrial plant sells to itself.

Since power equipment includes runs of distribution copper, the economic considerations here discussed apply to such cases. When a feeder becomes overloaded, the owner—utility or industrial plant—may install more copper or, alternatively, may improve power factor so that the old feeder can carry the increased load.

The Power Triangle

Power factor usually is known as the ratio of actual power to apparent power, expressed as kw ÷ kva. In the power triangle, Fig. 1, OA represents actual power, associated with active current. AB represents reactive power, associated with magnetizing current. (The magnetizing current is necessary to operation of motors and other inductive devices, but its associated KVAR does not result in useful power realized at the load.) OA and AB add together, vectorially, to form OB, which represents kva, apparent power, associated with total line current. Total line current determines the rate at which power equipment will become overheated, so power equipment is rated in kva.

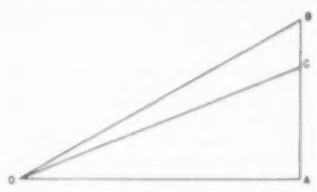


Fig. 3. Effect of adding capacitors
AB = kvar required by load
BC = kvar furnished by capacitors
AC = kvar furnished by generating station

Fig. 4.

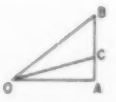


Fig. 5.

Application for Load Relief

By "overload" we mean kva overload, regardless of the value of load kva.

Note that decreasing AB (kvar), while keeping OA (kw) constant, will decrease OB and make OA/OB a larger ratio, i.e., will raise (improve) power factor.

Keeping kw and line voltage constant, the total line current varies inversely as power factor. If power factor is low, total line current is high and all equipment carrying the total current must be large enough to carry that current without overheating.

Capacitors and the Power Triangle

Magnetizing current is called "lagging" because its waveform lags, in time, behind the voltage waveform. Capacitors, on the other hand, use "leading" current that goes through its various values, during each cycle, *before* the voltage goes through its corresponding changes. Since leading current is the negative of lagging current, a capacitor *using leading* current is equivalent to a device *furnishing lagging* current. If enough capacitors are added to furnish all of the magnetizing current required by inductive loads, kvar is zero on the power triangle, kw equals kva, and power factor equals 1.00, its maximum value.

In the power triangle of Fig. 2, triangle OAB represents a load with low, lagging power factor.

In Fig. 3, the addition of capacitors has reduced kvar to the value AC, and the new kva (OC) is less than before. The same kw load, OA, is being carried in each case.

To see how capacitors become less effective at higher power factors, compare Fig. 4 with Fig. 5. Fig. 4 shows an extremely low power factor, in which a reduction BC of kvar results in a nearly equal reduction in kva. Figure 5 shows an extremely high power factor, in which the reduction BC of kvar makes little change in kva.

Economic Factors

Power companies have two solutions to the problem of low power factor. They are:

(1) If low power factor is due to the customer's loads, use a rate schedule that requires the customer to pay for the reactive kva (kvar) used by his low power factor loads. The customer will then be encouraged to raise his power factor, and the power company will benefit because it will no longer be required to force such large amounts of magnetizing current through its generators, transmission lines, transformers, and secondary distribution lines.

(2) Install capacitors at the generating station and on the distribution lines. The capacitors improve power factor *all the way back* to the generator, and in the generator as well. This method (2) is used for these cases:

a The customer is not interested in improving his power factor, but prefers to pay the penalty in his monthly billing. In this case, the power company is being reimbursed for pushing kvar through their equipment; yet it may be possible that they can relieve themselves, at justifiable cost, of some of the kvar burden by putting capacitors on *their own* lines.

b The customer has improved his power factor to a value high enough so that he escapes the power factor penalty clause in the billing. But the persistent distribution engineer asks, "Can we, at the power generating station, improve power factor still further by installing our own capacitors?" The answer is "Yes." It remains to be seen whether such further power factor improvement will be worthwhile from an economical standpoint.

Now, if the power equipment is not overloaded with too many kva, the purchase of capacitors to connect to the lines would seldom be justifiable as a means of saving money—nor would be the purchase of extra transformers not needed to relieve an overload. With capacitors, some saving *would* result, because the capacitors would furnish leading kvar that would otherwise need to be furnished by the generator and transmission lines; but the saving would be an I^2R saving of energy, and not of great importance as compared to investment costs.

The real test of capacitor advisability comes when the power company equipment is overloaded. The kva overload *must* be relieved; the customer *must* be given reliable service. Two (not mutually exclusive) courses of action are available:

(1) Purchase additional power equipment. If only one substation is overloaded, install another bank of transformers to take part of the load. If the entire generating station is overloaded, put in another generator. But keep in mind the costs—from $10 to $30 per kva of power equipment purchased.

(2) Purchase capacitors for the power plant. Place the capacitors near the low power factor loads, possibly at the substation. But keep in mind the costs—from $5 to $20 per kvar of capacitors purchased.

How Far To Go?

It might appear, at first glance, that capacitors would always be a better buy than power equipment to relieve overload, because their unit cost is usually less. The conclusion is not necessarily valid, because a dollar's worth of capacitors may not be able to substitute for a dollar's worth of power equipment. In general, if power factor is low before relieving the overload, capacitors would be the better buy as the means of relieving the overload; if power factor is high after relieving part of the overload, power equipment would be the better buy as the means of further relieving the overload. Usually, it will be desirable to install capacitors until power factor reaches some value from 0.9 to 0.95. Beyond that point, if the kva overload has not been relieved sufficiently by the capacitors, additional power equipment *in addition to the capacitors already added* will be the most desirable way to relieve the overload.

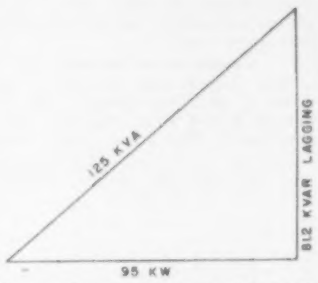


Fig. 6. In this case Pf = 95 ÷ 125 = 0.76

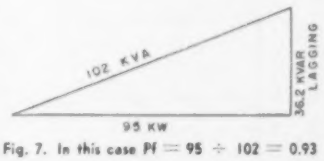


Fig. 7. In this case Pf = 95 ÷ 102 = 0.93

The nature of power factor rela-

tionships (relations between kva and kvar, keeping kw constant) are such that at low power factors only a few kvar are required to substitute for one kva, and those few kvar will cost less than the one kva; whereas at high power factors *many* kvar are required to substitute for one kva, and those many kvar will cost *more* than the one kva.

It can be shown[1] that the "Cost to buy and install one kvar to improve power factor" divided by "Cost per kva of power equipment" equals sine θ, where θ is the power factor angle, and where load kw is held constant. The nomogram solves for the cosine of the angle whose sine is θ, to give a direct indication of the power factor at which the economic limit is reached. At the economic limit (transfer point), capacitor effectiveness has dropped off so much that the total cost of the capacitors required to reduce the load one more kva exceeds the total cost of the power equipment required to carry one more kva.

Example on the Nomogram

The dotted line represents the solution to a hypothetical case in which a 100 kva substation was overloaded. The actual power load never exceeded 95 kw, but apparent power peak loads of 125 kva were experienced (at a power factor of 0.76) for uncomfortably long periods.

The overload could have been relieved by installing three 10 kw transformers to carry part of the load. But the cost would have been $900, or $30 per kva.

[1] Sam H. Pollock, "How Many Capacitors Can Be Economically Applied?" *Electrical World*, Nov. 22, 1947, page 108.

Table I

	Initial Conditions	After installing 30 kw of transformers only	After installing 45 kvar of capacitors only
Total kw	95	95	95
Total kva, peak	125	125	102
Power factor	0.76	0.76	0.93
Added cost		$900	$378

Fig. 8. Pf = 95 ÷ 99 = 0.96

Fig. 9. Pf = 95 ÷ 98.1 = 0.969

It was suggested that 45 kvar of capacitors be installed to raise the power factor to 0.93, thereby dropping the peak load to 102 kva. (kw load would remain at 95.) The capacitors would come in three units of 15 kvar each and the total installed cost, with switching equipment included, would be $378, or $8.40 per kvar. Since peak load was reduced 23 kva, at a cost of $378, it cost only $16.45 for each kva of load reduction. That's cheaper than $30 per kva for new transformers.

The conditions are summarized in Table I.

Where does the nomogram come in? In the example, the "Cost to buy and install one kvar (without changing kw) to improve power factor" is $8.40. The "Cost per kva of power equipment" is $30. The constructed line crosses "Power factor at which the costs balance" at 0.96. The nomogram warns that it is poor economics to improve power factor beyond 0.96 through the use of capacitors costing $8.40 per kvar, if power equipment costs $30 per kva. In the example, power factor was raised to 0.93 with "standard unit" capacitors, the overload was relieved, and a satisfactory solution has been found. However, there was economic justification for 0.96 power factor if standard equipment sizes had happened to raise it that high.

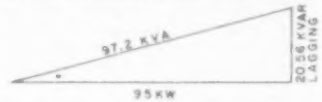
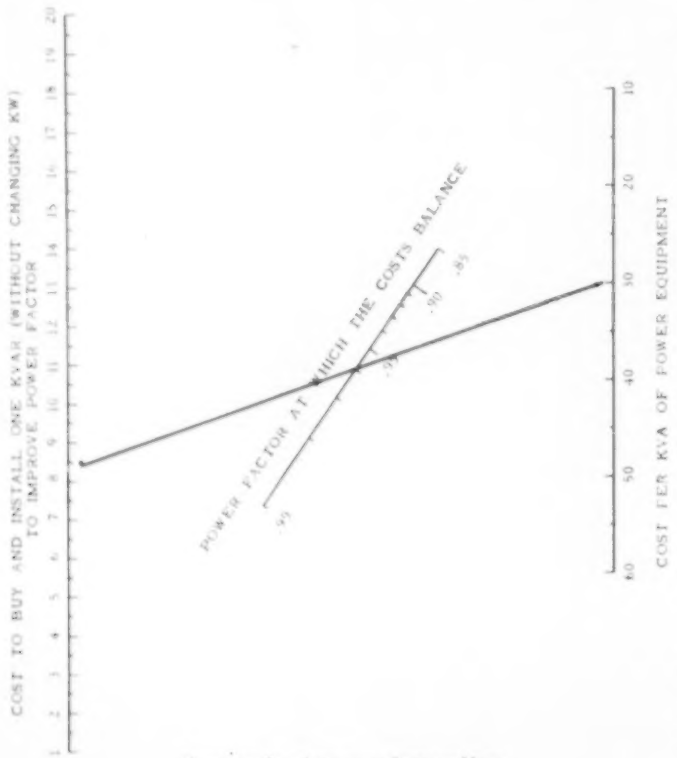


Fig. 10. Pf = 95 ÷ 97.2 = 0.977


COST TO BUY AND INSTALL ONE KVAR (WITHOUT CHANGING KW) TO IMPROVE POWER FACTOR
COST PER KVA OF POWER EQUIPMENT
POWER FACTOR AT WHICH THE COSTS BALANCE
.95
.90
.85

Numogram for solving power factor problems

The Method of Exhaustion

To understand why 0.96 represents the economic limit, see Fig. 6 through 10. Fig. 6 represents original conditions in the example.

Figure 7 represents conditions after installing 45 kvar of capacitors. Note that kva dropped 23 when kvar was reduced 45.

Figure 8 shows the "economic limit" condition found from the nomogram. Note, comparing with Fig. 7, that kva dropped 3 when kvar was reduced 8.5.

Now, let us see what happens if we spend $30 for 3.57 additional kvar of capacitors at $8.40 per kvar. Fig. 9 represents the new conditions.

Note, comparing with Fig. 8, that kva dropped 0.9 when kvar was reduced 3.57. For an expenditure of

(Continued on page 116)

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

☆

THE HIGH PRICE OF FORGETTING

It is human to forget, and this human weakness is taken into account by engineers who design controls for power apparatus. They know operators will forget to close valves, open switches, read meters, or will forget some step in the operating sequence of a series of controls. To protect power equipment against such forgetfulness, designers include lockouts and interconnections, electric eyes, time relays and warning bells and signal lights. But despite these modern automatic safeguards there are still countless opportunities for little acts of omission by operators to turn the useful energy of the equipment into destructive forces. The following incident taken from the records of the Hartford Steam Boiler Inspection and Insurance Co. shows what happens when operators *forget*.

This incident involved a gas-fired water tube boiler in a central station plant. When this boiler was shut down by the fireman, he closed the main gas valve but forgot to close one of the four burner cocks. Two days later another fireman prepared to put the boiler back on the line. *He* forgot to check the burner cocks before opening the main gas line valve. About three minutes elapsed between the time he opened the main valve and had prepared the lighting-off torch. During that time gas poured into the furnace through the cock which had been left open, and when the torch was inserted into the furnace a terrific explosion resulted. Three walls of the boiler setting were blown out, and the air preheater casing was badly damaged. The total cost of repairs resulting from this twice forgotten gas cock exceeded $23,000. It doesn't pay to forget. It might have been easy for the second operator (if he got out of it alive) to blame the first operator for leaving the burner cock open, but the second operator was also at fault for not checking up before he lighted the furnace.

☆

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THE PRACTICAL ENGINEER AND ELECTRICIAN

Hints on How to Weld Sheet Lead

Because of its low melting point the welding of sheet lead presents difficulties. However, by observing certain rules of procedure as developed by the Linde Air Products Company, outlined here, the welding of sheet lead can be accomplished very satisfactorily

WITH some practice, you'll find that lead welding isn't too difficult to do. The important thing to remember is that the heavy, soft, dull gray metal melts quickly even under a small blowpipe flame. Large pieces of lead will even collapse under their own weight during welding if they're not supported properly. You have to be careful therefore not to use too much heat. This article gives you hints on making some of the simpler joints used in lead welding.

Getting Ready to Weld

The first step in getting ready to weld is to choose a welding tip and a welding rod. Table I gives rod sizes, and will help you choose the proper tip size. Rod should be of the same type metal as the parts you're welding. For large jobs, homemade rod can be made by cutting strips from sheet lead. Always scrape the rod clean just before welding.

Some simple lead joints you can try making are shown in Fig. 1. Lap and flanged joints are made by bending the sheets. Use a knife to prepare butt joints. First cut the vee with a knife, then scrape the facing edges clean. Tap the sheets with a mallet for a close fit.

Making a Lap Joint

To make a lap joint in sheet ⅛ in. thick, first scrape the exposed edges and overlapping surface of both sheets. Then tap the joint with a wooden mallet to bring the sheets into close contact.

Use the welding tip recommended in Table I, and set the regulators for the pressures recommended by the blowpipe manufacturer for lead welding. Adjust the blowpipe for the tiny, pointed, neutral or slightly excess acetylene flame shown in Fig. 2.

After you get the proper flame, hold the blowpipe so that the flame is pointed straight at the surface of the work with the end of the inner cone almost touching the surface. Make the weld by moving the flame in a series of arcs toward the overlap and then straight away as shown in Fig. 3. Heat a spot on each sheet until a tiny puddle forms. Concentrate the flame a bit more on the lower sheet so that it will melt at the same time that the upper sheet melts. As soon as the puddle forms, fusing the two sheets together, lift the blowpipe away quickly. Melt a new spot, overlapping the first, the same way. The idea is to make a series of spot welds.

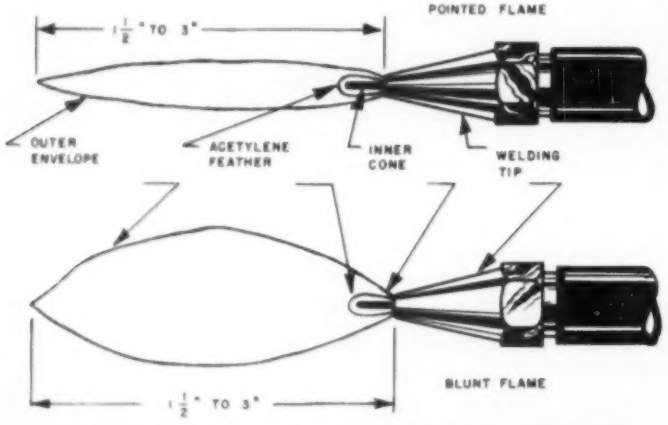


Fig. 1. Practice making these four types of joints used in lead welding operations

Making a Butt Joint

To make butt welds in lead sheet ½ in. thick, prepare the edges as shown in Figure 1. First scrape both edges to be joined with a knife; then bevel an angle between the butted surfaces. Tap lightly with a wooden mallet to align the sheets. Next scrape the end of a ⅜ in. lead rod with the knife. Set the regulators as you did to make a lap joint. Again, adjust the blowpipe for the pointed slightly excess acetylene flame.

Hold the blowpipe flame at one end of the joint and place the end of the rod in the flame. A drop of metal from the rod should be added just as the edges of the nose of the butt joint melt together. Deposit a drop of rod at a time along the bottom of the vee. When you weld the other end of the joint, let the weld cool a little, then wire brush it.

Now adjust the blowpipe for the blunt flame shown in Fig. 2. Deposit another layer of weld metal right on top of the first layer. Melt the rod metal you deposited before and the bevelled sides. Then add a drop of rod at a time until you reach the other end of the joint. Make as many more passes as needed until you fill the beveled area with rod metal.

Vertical Welding

VERTICAL LAP JOINT—Start welding at the bottom of vertical seams and work upward. If the lower end of the weld does not rest on another lead plate, use a small plate or rod to support the first drop of molten weld metal. When this drop hardens it will support the next overlapping drop.

First clean the areas of both overlapping surfaces. Move the blowpipe flame in a circular motion as shown in Figure 4. The overlapping edge supplies weld metal that gives a rounded finish to the joint. Move the flame higher and repeat this process as shown as the first puddle solidifies. Carry the weld to the top of the joint this way.

VERTICAL BUTT JOINT—Now practice making a vertical butt weld, in lead ½ in. thick, using an iron mold. Make the mold as shown in Fig. 5. First place the mold over the joint, then melt the bevelled edges and welding rod so that they fuse together and fill the mold. Be sure that the lead in the bottom of the

TABLE I
Tip and Rod Sizes for Welding Lead

Sheet Designation lb.	Sheet Thickness in.	Welding Rod Diameter in.	Diameter of Flame Port Drill Size
1	1/64	1/32	79
2	1/32	1/16	74
4	1/16	1/8	70
8	1/8	1/4	70
12	3/16	1/4	70
16	1/4	3/8	70
32	1/2	3/8	65
48	3/4	1/2	56
60	15/16	5/8	56

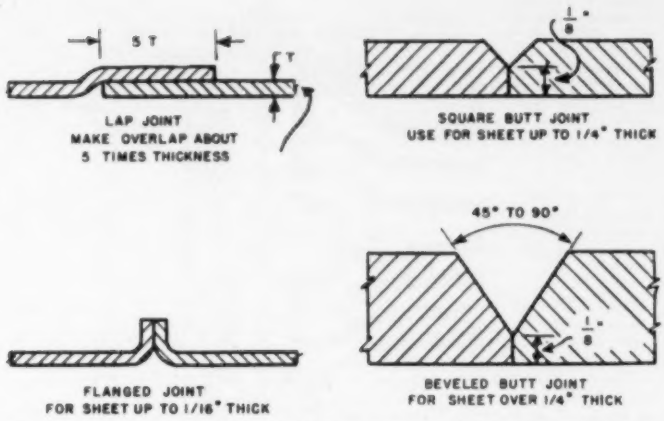


Fig. 2. Always consult Table L for a welding tip. Use the pressures recommended by the blowpipe manufacturer

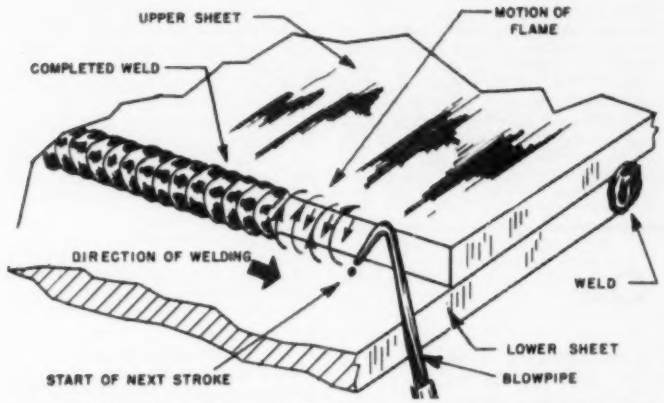


Fig. 3. Make lap welds by moving the flame in a series of short arcs toward the overlap, then straight away

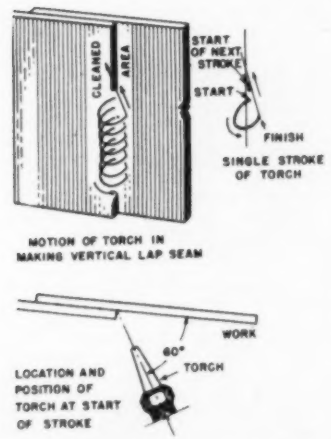


Fig. 4. Move the flame in a series of small, overlapping circles from the underneath sheet to lapped edge and back

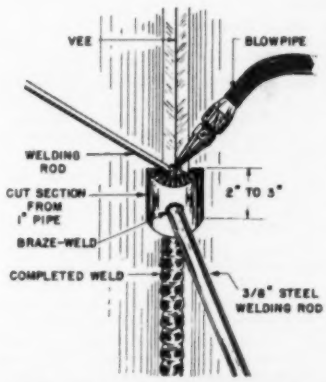


Fig. 5. An iron mold will help you make vertical butt welds

mold is in a molten state before you add more lead from the rod.

Things to Remember

Remember that it takes practice to make strong joints in lead. Practice on scrap lead pieces. Try flame adjustments, and practice moving the blowpipe and the welding rod.

Proper ventilation is important so that you don't inhale any harmful fumes during welding. Work outdoors or in a well ventilated place. If you must work in confined areas, use a blower to blow away the fumes.

WHY THE TURBINE OVERSPEEDED

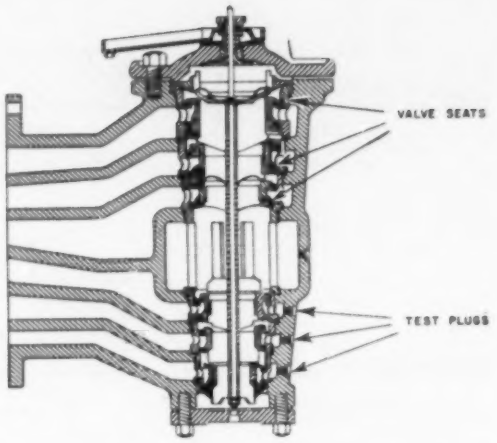
By ALBERT H. MOULTON

A 2500 KW TURBINE had been in service several years and had run satisfactorily with very little maintenance, when one day when it was being started up and after it had been brought up to speed with vacuum and throttle just "cracked" about three quarters of a turn open, it overspeeded and tripped itself out when the throttle was open about 2 turns; this with the field on.

This turbine had poppet valves operated through a hydraulic cylinder in connection with an inertia governor. A casual inspection showed the governor to be OK. It was in the no load position and the indicator marks on valve stem inlet valves indicated "closed" and we thought it was just a freak trip due to a slight derangement of the emergency tripping device. The emergency was reset without any trouble as soon as the speed dropped back to normal.

The throttle was slowly opened again with the same result. Opening the throttle more than 2 turns the turbine would overspeed and trip out, closing the butterfly emergency valve which held tight. This being so we decided to put turbine line and carry the load as we needed the machine to carry the load which was quite heavy at this time, but it had to be synchronized by throttling. Once on the line it behaved all right and responded to governor control except that we could not unload below 50 kw without the turbine tripping out when line switch was opened, so we had to put it both on and off the line under throttle control. The management thought it best to have a turbine man from the turbine company come and check it and remedy the trouble. The turbine expert came in due time and went over the governor, hydraulic gear and steam valves. The valves were removed, valves and seats were examined, and except for a slight roughness on valve faces and seats which was so slight that it did not seem possible that there could be much leakage, but when a test was made by taking out test plugs in steam ports leading to turbine noz-

Section of turbine control valve



zles, reassembling valves in closed position and letting in steam, it fairly whistled through two of the ports leading from chest valves and one or two others leaked a little too. The throttle was quite light, so the valves were removed again and once more examined thoroughly but as before, there seemed to be no reason for all that leakage, but leakage there was.

After a conference with the chief it was decided to grind in the valves as a routine procedure, with the idea if there was any slight warping or other causes for leakage it would show up in the process so each valve was ground to its seat. Most of them seated perfectly, but two of the large ones did not seat quite so well and seemed raised up a little higher than the others and when one of them was tapped gently with the end of a hammer handle, it was discovered that it was loose and had turned itself out more than a full turn from its seat, tapping the rest of the valve seats revealed another large seat in about the same condition and a couple of smaller ones slightly loose.

As shown in the sketch, these were renewable valve seats. They were of a special alloy and screwed into cast steel diaphragms. Unequal expansion dissimilar metals, plus vibration, both due to turbine rotation which was not excessive, and the action of steam through valves had caused them to loosen and turn in their seats in the out direction. Some of the threads were a little worn and steam found its way through them and around under seats and into the turbine, which accounted for the overspeeding with all valves closed.

We then went to work and screwed the loose ones out and cleaned off the seats and seat bearings of particles that had gotten under them, cleaned up the threads, and after coating all threads with a metallic compound were screwed back into the seat bearing. Next the valve seats were straked down. That is, the steel around the seats was upset by special tools similar to caulking tools. This job was a success as the turbine ran several years after without any more of this trouble.

Flash Points of Fuel Oils

This is the eighth article in Mr. Schmidt's series on the characteristics of fuel oils. In this, he discusses the flash point of fuels—what it means and how it varies. He describes the types of testing equipment available and the methods of testing. A comparison of the flash points of various oils will be found of value in evaluating your own oil

By PAUL F. SCHMIDT
Allied Oil Co., Inc., Cleveland, Ohio

AS FUEL OILS are heated, vapors are produced, which at a certain temperature flash, when ignited by an external flame. This temperature is called the flash point of the oil. If the heating is continued, sufficient vapors are finally driven off to produce a continuous burning, and not just a flash. This temperature is called the fire point.

Types of Testing Apparatus

There are two different types of instruments used in the fuel oil industry to test for flash and fire points: the Pensky-Martens or closed cup flash tester, and the Cleveland or open cup tester. With the closed cup tester, only the flash point is tested, while with the open cup, both the flash and fire points are obtained. The only difference between the two types of testers is that with the Pensky-Martens apparatus, the oil is heated in an enclosed cup, while with the Cleveland tester, the top of the cup is open.

With the closed cup, it is possible to retain the very light vapors, thus giving a faster or lower flash point than with the open cup, whereas the open container permits the air currents to blow the light vapors away, giving a slower or higher flash. Therefore, it is possible with the closed cup tester to detect very small amounts of light vapors that would otherwise not be detected with the open cup. The Cleveland tester is principally used for lubricating oils, but it is also used a great deal for fuel oils.

Methods of Testing

The method of testing is simply heating the oil and applying a small external flame across the surface of the oil at regular intervals until the vapors flash. With the Cleveland tester, the heating is continued until the vapors burn for 5 or more seconds, and this temperature is called the fire point. The closed cup tester is so constructed that it is not possible to obtain a fire point.

When specifying flash points, the type of instrument should also be included. The combustion engineer or operator usually likes to know the flash point of the oil, as an aid to his preheating and combustion, but if no instrument is named, the flash point becomes meaningless.

Comparison of Flash Points

As most heating of fuel oils occur in closed tanks and lines, the most important flash point is the one obtained by the closed tester. Also, some small burners are sensitive to extremely light vapors, which can only be detected by this type instrument. The main reason for the open cup flashes revert back to the initial uses of fuel oils, when it was the only type available. For all practical purposes, the closed cup flash

should be used, but as the open cup flash is also used, and may be helpful, the following comparisons are shown.

	Pensky-Martens Closed Cup Flash Point	Cleveland Open Cup Flash Point	Cleveland Open Cup Fire Point
No. 2 Oil	126°F.	175°F.	245°F.
	144	150	165
	160	180	200
	176	195	210
	204	215	240
	240	265	280
No. 4 Oil	170	200	230
	182	225	270
No. 5 Oil	100	160	260
	142	180	270
	210	240	280
	245	280	340
No. 6 Oil	190	265	325
	224	290	380
	250	320	415
	330	360	440

As the table shows, the light oils usually have the lower flash points. This is true in most cases, but not all the time. You will also notice that some of the heavy oils have flashes lower than the light oils. This can be caused by various factors.

A great amount of residual fuel oil is blended, and the blending materials can be of many different varieties, such as, No. 1 and 2 oils, kerosene, gasoline, and crude oil. No. 2 distillate is most frequently the blending oil, and as it has a lower flash than the heavy oil, the final flash point of the blend will be lower. If crude oil is used, the flash point may become exceedingly low, as most crude oils are volatile. Improper blending with low flash oils can lower the flash points below the safe limits.

If the closed cup flash of a heavy oil is below 140 degrees, it is possible that the oil has become contaminated or blended with some low flash material. Normally, as an oil is refined, the material produced falls within a definite boiling range. This means, that as the oils are refined, the flash points of different products become higher, as the oils become heavier. Therefore, the flash points are more or less progressive, but between the refiner and consumer, as well as in the refinery itself, a number of items can change or alter the original flash point. An oil can become contaminated with a lower flash oil in the refinery, bulk plant or transport, due to the presence of a lighter material in the pipelines and tanks.

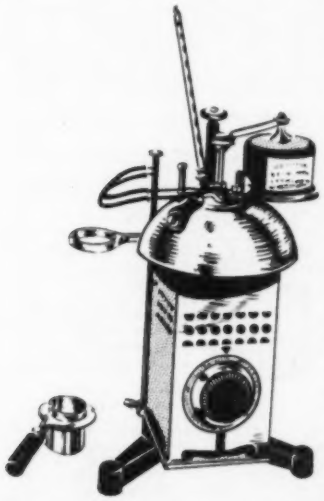


Fig. 1. The Pensky-Martens closed cup flash tester

Some oils have a low flash due to poor fractionation during the refining process. This means that some of the light materials are not stripped or properly vaporized. In other words, this material causing the low flash should have been included in the preceding fraction or lighter oil during refining, but was not, so it ends up in the succeeding, or heavier fraction.

Minimum Flash Points Advisable

To set a definite flash temperature and say it is too low is quite a job, as it can be low and cause no trouble, but as fair criteria, you can use the following temperatures.

1. Any oil not preheated — minimum flash point 100 F — below 100 F dangerous.
2. Any oil preheated — minimum flash point 120 to 150 F — below 120 F could be dangerous.

There is sometimes a legal minimum of 150 F flash point on the closed cup, which is required. A great many times this is overlooked, especially with blended oils, but again the general run of industrial fuel oils when correctly and properly refined will have 150 F or higher flashes.

The type of equipment, location of storage tanks, amount of preheating, and condition of equipment all tend to regulate the permissible flash point of an oil.

If the vents from storage tanks are located near any buildings, the flash point must not be too low. Heating of the oil when it has a low flash will drive off the volatile vapors, which escaping by means of the vents may be the source and cause of fire.

With low flash oils, the extent of preheating should be watched carefully, because with increased heating the volume of vapors will be greater. This can cause preignition at the burner, and for this reason, fuel oils should never be preheated above their flash points.

Too low a flash point indicates presence of light vapors that can cause the burner to start and then go out. This is usually found when the percentage of light vapors is extremely small. They burn, but fail to ignite the succeeding portions of the oil immediately, which sometimes causes flashback, and smoke.

Leaking and badly connected equipment are all places of fire hazards when using low flash oils.

As we must watch for too low a flash point, we must also keep one eye open for the high ones. This usually causes little trouble with industrial oils and burners, except those burners of small design. With industrial oils of grade No. 5 and 6, flash points are seldom higher than 300 F open cup, or 260 F closed cup,

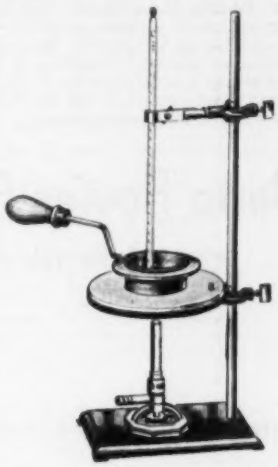


Fig. 2. The Cleveland open cup flash tester

which should cause no trouble. About the only trouble that can result from too high a flash point is that some trouble may occur in starting, especially with a cold furnace. No. 2 and 4 oils have flashes low enough to warrant easy combustion.

Spontaneous Ignition Point

It should be remembered that there is no relationship between the flash point and spontaneous ignition point. This ignition point is the temperature at which a mixture of oil vapors and air will ignite *without* the application of an external flame or spark. This spontaneous ignition point is very high, and there is no need to worry about it, but the difference should be understood.

Fire Point

Very little has been mentioned about fire point, because actually this test has little value, except to give a fair indication as to whether or not an oil is a blended one. If the temperature spread on the open cup tester between the flash and fire is very large, it usually shows it to be a blended oil.

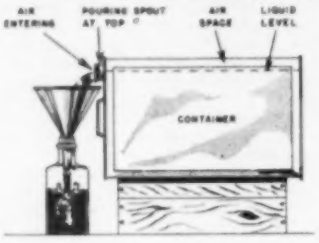
Sometimes the flash point is considered to be an indication of the presence of small volumes of light vapors or fractions more volatile than the main portion of the oil, while the fire point is indicative of

the temperature at which the main body of the oil begins to vaporize.

A number of people regard flash tests as insignificant, and in some cases it is true, but the main advantage of a flash point specification is to maintain a uniform material to which the engineer and operator can become accustomed, thereby learning which precautions of safety to exercise, as well as for the preheating of his oil. Therefore it is best to pay a little attention to flash points, particularly if the oils are heated to a high temperature.

POURING LIQUIDS FROM METAL CONTAINERS

IN POURING LIQUIDS from metal containers of square or rectangular shape, hold the container as shown. This will permit air to enter above the liquid instead of having to enter through it, resulting in elimination of gurgling of the liquid.



HOLDING UP WANDERING LEADS

WHEN TEMPORARY electric light leads have to be used in tanks or similar plans for cleaning or repair, there is usually difficulty in holding the lamp and leads up. There are usually no projections to hang them on. However, since tanks are made of ferrous metal it is only necessary to clean a small surface of the metal so that a small permanent magnet can be fixed there and the lamp and leads tied up. The lamp and leads can be held overhead, which is more convenient for working and rendering mechanical damage less likely.

Basic Power Plant FIGURING

A Review for Old-Timers—A Must for Young-Timers

By WILLIAM H. ENGELMAN
Mechanical Engineer, Department of Water & Light
City of Cleveland, Ohio

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How to Use Standard Mathematical Tables to Speed Up Your Engineering Calculations

AS YOU GO along in power engineering and master the fundamental principles and the basic methods of figuring outlined in these articles, you will be more and more able to use mathematical tables. You will find these tables in all the standard engineering handbooks.

For example, when you want to find the value of 1 ÷ 9.633, you know how to do it by division; but from the tables of reciprocals of numbers you can read it directly, saving yourself time and eliminating several chances for error in the process of dividing.

In all branches of engineering the ordinary commercial calculations are not sufficient. Many other operations besides multiplication, division, addition and subtraction are very essential in the sciences. These operations mean finding squares, cubes, square roots, cube roots, reciprocals, circumferences and areas of circles, and so on. Numerous tables have been compiled to make calculations much easier in engineering but their uses or value is not always fully

FIGURE 1 — THE "HOW" AND "WHY" OF THE SQUARE ROOT

THE SQUARE OF THE SUM OF TWO NUMBERS IS EQUAL TO THE SQUARE OF THE FIRST, PLUS TWICE THE PRODUCT OF THE FIRST AND SECOND, PLUS THE SQUARE OF THE SECOND. THUS WE HAVE

$(a+b)^2 = (a+b)\times(a+b) = a^2+ab+ab+b^2 = a^2+2ab+b^2$

EXAMPLE: TAKE 125, IT CONSISTS OF (100 + 25) OR (20 + 5)

$125^2 = (100+25)^2 = 100^2+2\times100\times25+25^2 = 15{,}625$

$125^2 = (20+5)^2 = 20^2+2\times20\times5+5^2 = 15{,}625$

EXAMPLE: THE SQUARE ROOT OF 15,625 (3 SETS OF FIGURES) GIVES 3 FULL FIGURES IN THE ANSWER, WHICH IS 125

$\sqrt{15{,}625} = 100$ (3 FULL FIG)

$a\times a$	$= 100\times100 = 10{,}000$
$2a\times b$	$= 2\times100\times25 = 5{,}000$
$b\times b$	$= 25\times25 = 625$
$(a+b)^2$	$= 15{,}625$

$\sqrt{15{,}625} = 125$

$\sqrt{45,724.44} = 676.2$ (4 FULL FIG)

20×10	$= 200$
$b\times7$	$= 977$
$2a\times b$	$= 9{,}849 = 1{,}077\times7$
$b\times b$	$= 49$
	$= 9{,}349$
$2a\times350$	$= 90{,}700 = 1{,}346\times6$
$b\times7$	$= 27{,}044$
	$= 27{,}049 = 13{,}522\times2$

FIGURE 2 THE "HOW" AND "WHY" OF THE CUBE ROOT

THE CUBE OF THE SUM OF TWO NUMBERS:

$(a+b)^3 = (a+b)\times(a+b)\times(a+b) = a^3+3a^2b+3ab^2+b^3$

THIS FORMULA IS USED FOR EXTRACTING THE CUBE ROOT

EXAMPLE:

$\sqrt[3]{15{,}625} = 25$ ANS

$a^3+2+2+2$	$= 8$
$3a^2\times b\times20^2$	$\times1200 = 7625$
$3ab\times3\times20\times5$	$= 900$
$b^2\times5\times5$	$= 25$
	$1525 \quad 7625$
$b\times5$	
$a^3+3a^2b+3ab^2+b^3$	

GROUP NUMBER INTO 3 FIGURES IN EACH GROUP. EACH GIVE ONE FIGURE IN THE CUBE ROOT. IN THE EXAMPLE 2 GROUPS GIVE 2 FIGURES

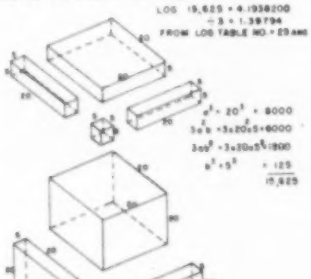
15,625 ANS 25

SOLVING THE CUBE ROOT BY LOGS.:

LOG 15,625 = 4.1938200

$\div 3 = 1.397934$

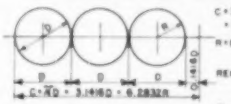
FROM LOG TABLE NO. = 25 ANS



a^3	$= 20^3 = 8000$
$3a^2b$	$= 3\times20^2\times5 = 6000$
$3ab^2$	$= 3\times20\times5^2 = 1500$
b^3	$= 5^3 = 125$
	$15{,}625$

FIGURE 3 PROPERTIES OF THE CIRCLE

LET: C = CIRCUMFERENCE, (PERIMETER, PERIPHERY)
D = DIAMETER, R = RADIUS, A = AREA
π = PI, A CONSTANT = 3.1416 (3.1415926536)



$C = 3.0+0.1416D$
$= 3.1416D$
$R = D/2$; $C = 2\pi R$
$= 6.2832R$
REC OF $\pi = 0.3183$
$= \frac{1}{3.1416}$
$D = 0.3183C$

THE CONSTANT $\pi/4 = 0.7854 = 0.7853982$ (USE FOUR FIG. ONLY)

$\text{AREA } A = \frac{D^2\pi}{4} = 0.7854\,D^2 = .7854\times3.1416\,R^2 = \frac{CR}{2} = \frac{CD}{4}$

$\text{DIA } D = \frac{C}{\pi} = \frac{C}{3.1416} = 0.3183C = \sqrt{\frac{4A}{\pi}} = \sqrt{1.27324A}$

$D^2 = \frac{4A}{\pi} = \frac{4}{3.1416}A = 1.27324A$

$\text{RAD } R = \sqrt{\frac{A}{3.1416}} = \sqrt{0.3183A} = 0.5642\sqrt{A} = \frac{C}{2\pi} = 0.1591C$

A PERFECT SQUARE EACH SIDE 10"
AREA OF SQUARE = 10×10 = 100.0 $\square$"
AREA OF CIR = $.7854\times10^2 = 78.54\square$"
AREA OF FOUR CORNERS
= THE DIFFERANCE = 21.46 $\square$"

USING THE RADIUS R:

AREA	$= R^2\pi = 5^2\times3.1416 = 78.54\square$"
C	$= 2\pi R = 6.2832\times5 = 31.416$"
C	$= D\pi = 3.1416\times10 = 31.416$"
A	$= \frac{CR}{2} = \frac{31.416\times5}{2} = 78.54\square$"
A	$= \frac{CD}{4} = \frac{31.416\times10}{4} = 78.54\square$"
D	$= 0.3183C = 0.3183\times31.416 = 10$"
D^2	$= \frac{4A}{\pi} = \frac{4\times78.54}{3.1416} = 100$ SQ IN

$D^2 = 1.27324\times78.54 = 100$ SQ IN

understood. It is the aim of this article to explain the working of the skeleton set-up of such a table as found in all engineering handbooks.

Any engineer with a little practice can use these tables to turn laborious, cumbersome calculations into easy ones and, at the same time, reduce many of the chances of errors otherwise possible.

A practical example, with a definite value for N is explained in Table I. In the first column under N are those figures for which the other items are to be found. Remember that N may be any figure, whether a decimal or whole number, such as 0.37, 3.7, 37, 370, 3700. In this example let the value of N be 370 and all other items based on it.

N^2 or $N \times N = 370 \times 370 = 136{,}900$; it is also the area of a perfect square whose sides are 370.

The square root of 370 is 19.23538; it is that number which, when multiplied by itself, gives N, thus: $19.23538 \times 19.23538 = 370$.

The square root of 10×370 or of 3700 is 60.82763.

$N^3 = 50{,}653{,}000$, the cube of N, since $370 \times 370 \times 370$ is 50,653,000.

N^3 is also the volume of a cube whose sides are 370.

The cube root of 370 is 7.179054, because 7.179054^3 is $7.179054 \times 7.179054 \times 7.179054 = 370$.

The cube root of 10×370 or of $3700 = 15.46680$.

The cube root of 100×370 or of $37{,}000 = 33.32222$.

The reciprocal of a number is 1 divided by that number, or 1/N.

Let N be 370; then the reciprocal is 1/370 or 0.00270270.

The reciprocal of $1{,}000 \times 1/N$ is 1,000/370 or 2.702703. This is mostly used to avoid the zeros ahead of the real figures, to get greater accuracy, and to minimize errors due to the zeros carried.

Log of 370 is 2.56820, it is the logarithm to the base 10.

Where: 2 is the characteristic and 0.56820 the mantissa.

$N \times \pi$ (Pi) is the circumference of a circle whose diameter is N.

The constant π is 3.14159265 but mostly taken as 3.1416.

The constant 3.1416 is indicated by the symbol π (Pi) taken from the Greek alphabet, and pronounced pie.

$370 \times \pi$ is 370×3.14159265 or 1,162.389, which is the circumference.

$N^2\pi/4$ is the area of a circle whose diameter is N, in this case 370.

The constant $\pi/4$ is $3.14159265/4 = 0.78539816$; round this off to 0.7854 for all practical problems.

The area is $370 \times 370 \times 0.7853982$ is 107,521.0 (written as $N^2 \times 0.7854$).

Moving The Decimal Point

The moving of a decimal point under N and its effect upon N^2, N^3, $N\pi$, and $N^2\pi/4$ can best be seen by taking these items separately, as shown in Table I.

TABLE I.

N	N^2	N^3	πN	$N^2\pi/4$
←1→	←2→	←3→	←1→	←2→
0.37	0.13 69	0.050 653	1.1623893	0.10 75 21
3.7	13.69	50.653	11.623893	10.75 21
37	13 69.	50 653.	116.23893	10 75.21
370	13 69 00.	50 653 000.	1162.3893	10 75 21.
3700	13 69 00 00.	50 653 000 000.	11623.893	10 75 21 01.

The moving of the decimal point under N and its effect upon the square root of N and the cube root of N, as shown in Table II.

TABLE II.

N	$\sqrt{N}$	$\sqrt[3]{N}$	$\frac{1}{N}$	$1000 \times \frac{1}{N}$
.37	* 0.6082763	† 0.7179054	2.7027027	2702.7027
3.7	** 1.923538	†† 1.546680	0.2702703	270.27027
37	* 6.082763	††† 3.332222	0.0270270	27.027027
370	** 19.23538	† 7.179054	0.0027027	2.7027027
3700	* 60.82763	†† 15.46680	0.0002703	0.27027027

Values are taken from table for easy comparison.

This set-up shows clearly that, when decimal point under N is moved 1 place to either right or left, it must be moved:

2 places to either right or left under N^2.
3 places to either right or left under N^3.
2 places to either right or left under $N^2\ \pi/4$.
1 place to either right or left under $N\ \pi$.
½ place to either right or left under $\sqrt{N}$.
⅓ place to either right or left under $\sqrt[3]{N}$.

Under SQUARE ROOT note the similarity of the figures marked * and **.

The square root of 0.37, 37 and 3700 have all the same figures.

The square root of 3.7 and 370 have also the same figures.

Under CUBE ROOT note the similarity for figures marked †, ††, and †††.

The cube root of 0.37 and 370 have the same figures.

The cube root of 3.7 and 3700 have the same figures.

The cube root of 37 and 37,000 have the same figures.

Here is another way of showing the effect upon the square root and the cube root when moving the decimal point under N.

Similar figures have been grouped under one column, it should be clear that two columns were required for the SQUARE ROOT and three columns for the CUBE ROOT.

TABLE III.

N	$\sqrt{N}$		$\sqrt[3]{N}$		
0.037	0.1923538	.....	0.3332222	.....	.....
0.37	.....	0.6082763	.....	0.7179054	.....
3.7	1.923538	.....	.....	.....	1.546680
37.	.....	6.082763	3.332222	.....	.....
370.	19.23538	.....	.....	7.179054	.....
3700.	.....	60.82763	.....	.....	15.46680
37000.	192.3538	.....	33.32222	.....	.....

It should be noted that the square root of 0.037, 3.7, 370, and 37,000 contains the same figures but the decimal moved one figure in each case, while under N it was moved two figures.

The cube root of 0.037, 37, and 37,000 contains the same figures in the root but the decimal moved one figure in each case while under N it was moved three figures.

The proof is: 1×1 is 1; 10×10 is 100; 1.0 to 100.0 (Square) $1 \times 1 \times 1$ is 1; $10 \times 10 \times 10$ is 1000; 1.0 to 1000 (Cube)

TABLE IV.

N	N^2	$\sqrt{N}$	$\sqrt{10N}$	N^3	$\sqrt[3]{N}$	$\sqrt[3]{10N}$	$\sqrt[3]{100N}$	RECIPROCAL $\frac{1}{N}$	RECIPROCAL $1000 \times \frac{1}{N}$	LOG.	N = Diameter Circum. $N \times \pi$	N = Diameter Area $N^2 \times \pi/4$
←1→	←2→	←½→		←3→	←⅓→						←1→	←2→
0.14	0.0196	0.3741657	1.183216	0.002744	0.5192494	1.118689	2.410142	7.1428571	7.142.857	−1.14613	0.439823	0.01539380
0.37	0.1369	0.6082763	1.923538	0.050653	0.7179054	1.546680	3.332222	2.7027027	2.702.703	−1.56820	1.162389	0.1075210
0.85	0.7225	0.9219544	2.915476	0.614125	0.9472682	2.040828	4.396830	1.1764706	1,176.471	−1.92942	2.670354	0.5674502
1.4	1.96	1.183216	3.741657	2.744	1.118689	2.410142	5.192494	0.7142857	714.2857	0.14613	4.398230	1.539380
3.7	13.69	1.923538	6.082763	50.653	1.546680	3.332222	7.179054	0.2702703	270.2703	0.56820	11.62389	10.75210
8.5	72.25	2.915476	9.219544	614.125	2.040828	4.396830	9.472682	0.1176471	117.6471	0.92942	26.70354	56.74502
14	196	3.741657	11.83216	2,744	2.410142	5.192494	11.18689	0.07142857	71.42857	1.14613	43.9823	153.938
37	1,369	6.082763	19.23538	50 653	3.332222	7.179054	15.46680	0.02702703	27.02703	1.56820	116.2389	1,075.210
85	7,225	9.219544	29.15476	614,125	4.396830	9.472682	20.40828	0.01176471	11.76471	1.92942	267.0354	5,674 502
140	19,600	11.83216	37.41657	2,744,000	5.192494	11.18689	24.10142	0.00714286	7.142857	2.14613	439.8230	15,393.80
370	136,900	19.23538	60.82763	50,653,000	7.179054	15.46680	33.32222	0.00270270	2.702703	2.56820	1,162.389	107,521.0
850	722,500	29.15476	92.19544	614,125,000	9.472682	20.40828	43.96830	0.00117647	1,176471	2.92942	2,670.354	567,450.2
1400	1,960,000	37.41657	118.3216	2,744,000,000	11.18689	24.10142	51.92494	0.000714286	0.7142857	3.14613	4,398.230	1,539,380
3700	13,690,000	60.82763	192.3538	50,653,000,000	15.46680	33.32222	71.79054	0.000270270	0.2702703	3.56820	11,623.893	10,752,101
8500	72,250,000	92.19544	291.5476	614,125,000,000	20.40828	43.96830	94.72682	0.000117647	0.1176471	3.92942	26,703.538	56,745,017

TABLE V.

MULTIPLES OF FREQUENTLY USED FIGURES (CONSTANTS) IN STEAM ENGINEERING.
TO AVOID DIVISION, RECIPROCALS ARE USED WHERE NECESSARY. SEE EXAMPLES BELOW.

N	πN = 3.1416	$\frac{\pi}{4} N$ = 0.7854	$\frac{1}{\pi} N$ = 0.31831	Cubic Ft to Gal N × 7.48	Gal to Cubic Feet N × 0.1337	Gal to Pounds Water	Cu Ft to Pounds Water	Cu In. to Gal 1/231 = 0.004329	Cu In. to Cu Ft 1/1728 = 0.0005787	Ft Hd to Pounds (psi) 0.433	Pounds (psi) to Ft Hd 2.31
1	3.1416	0.7854	0.31831	7.48	0.1337	8.335	62.35	4329	5787	433	231
2	6.2832	1.5708	0.62662	14.96	0.2674	16.670	124.70	8658	11574	866	462
3	9.4248	2.3563	0.95493	22.44	0.4011	25.005	187.05	12987	17361	1299	693
4	12.5664	3.1416	1.27324	29.92	0.5348	33.340	249.40	17316	23148	1732	924
5	15.7080	3.9270	1.59155	37.40	0.6685	41.675	311.75	21645	28935	2165	1155
6	18.8496	4.7124	1.90986	44.88	0.8022	50.010	374.10	25974	34722	2598	1386
7	21.9912	5.4978	2.22817	52.36	0.9359	58.345	436.45	30303	40509	3031	1617
8	25.1328	6.2832	2.54648	59.84	1.0696	66.680	498.80	34632	46296	3464	1848
9	28.2744	7.0686	2.86479	67.32	1.2033	75.015	561.15	38961	52083	3897	2079

The circumference = 12.75", dia. = 0.31831 × 12.75 = 4.05845"
The diameter = 12.75", circ. = 3.1416 × 12.75 = 40.0554"
The diameter = 12.5", area = 0.7854 × 12.5^2 = 122.7188 sq in.
89.5 cu ft to gal, 7.48 × 89.5 = 669.46 gal
42.0 gal to pounds, 8.335 × 42 = 350.07 lb
89.5 cu ft to pounds, 62.35 × 89.5 = 5,580.325 lb
42.0 gal to cu ft, 0.1337 × 42 = 5.6154 cu ft
9,875 cu in. to gal, 0.004329 × 9,875 = 42.7489 gal
9,875 cu in. to cu ft, 0.0005787 × 9,875 = 5.7147 cu ft
215 ft hd to psi, 0.433 × 215 = 93.095 psi
296 psi to ft hd, 2.31 × 296 = 683.76 ft hd

→ By using the values of multiples:

0.31831 × 12.75
159155 = 0.31831 × 5
222817 = 0.31831 × 7
63662 = 0.31831 × 2
31831 = 0.31831 × 1
4.0584525 Ans.

0.1337 × 42
2674 = 0.1337 × 2
5348 = 0.1337 × 4
5.6154 Ans.

Use of the Math. Tables by Interpolation

1) N^2 = 56,325,025; Square Root = ?

The table gives N^2 with 6 figures.

751^2 = 564001 — 563250
750^2 = 562500 — 562500 — $\frac{750}{1501}$ = 0.5
Diff. for 1 = 1501 Diff. = 750

Hence $\sqrt{56\,32\,50\,25}$ = 7,505 Ans. Four Groups of Figures Give 4 Fig. in Answer

2) What is the Square Root of 271.3?

Sq. Root of 272.0 = 16.49242
Sq. Root of 271.0 = 16.46208
Diff. for 1.0 = 0.03034
Diff. for 0.3 = 0.009102

16.46208
0.009102
16.471182 Ans.
By Interpolation

The Correct Answer Is 16.4711870 (Correct to 5 Decimals)

3) What is the Square Root of 2.7137

Looking under $\sqrt{10\,N}$

52.05766
+ 0.02879
52.08645 Ans.

$\sqrt{10 \times 272}$ = 52.15362
$\sqrt{10 \times 271}$ = 52.05766
Diff. for 10 = 0.09596
Diff. for 3 = 0.02879

4) 76.04^2 = ? Interpolate Between 76.1^2 & 76.0^2

76.1^2 = 5791.21 — 5776.00
76.0^2 = 5776.00 + 6.08
Diff. for 0.1 = 15.21 — 5,782.08
Diff. for 0.04 = 6.08 Ans.

Log 76.04 = 1.8810421
1.8810421
Log 76.04^2 = 3.7620842
No. = 5,782.08

5) The Square Root of 879.25 = ?

Sq. Root of 880 = 29.66479
Sq. Root of 879 = 29.64793
Diff. for 1 = 0.01686
Diff. for 0.25 = 0.004215

29.64793
0.004215
29.652145 Ans.

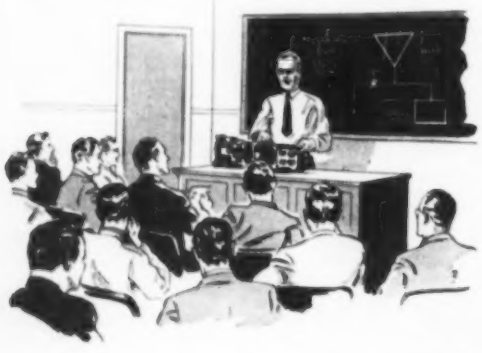
6) Diameter of a Circle = 76.04". Find the Area.

Area of 76.1" Dia. = 4548.406 sq. in.
Area of 76.0" Dia. = 4536.460 sq. in.
Diff. for 0.1 = 11.946
Diff. for 0.04 = 4.778

4536.460
4.778
4,541.238
Ans.

SOLVED BY LOGS

Log. 76.04 = 1.8810421
" = 1.8810421
$\pi/4$ = −9.8950899
Log. = 3.6571741
No. = 4,541.237



HOW ELECTRICAL engineers are assisting the medical profession by developing devices to measure body conditions, was reported recently before the AIEE. An instrument to obtain more detailed information concerning the functions of various parts of the circulatory system by directly measuring the pressure of the blood within the heart and the blood vessels, has been devised.

A plastic tube, called a catheter, is introduced through a hypodermic needle into the vessel under study. The instrument end of the catheter is led to a small chamber, one wall of which is a thin metal membrane, spaced a short distance from a fixed metal plate, thus forming a capacitance. Pressure changes at the end of the tube in the blood vessel are transmitted by a liquid back to the movable membrane. The varying membrane capacitance is measured by a high-frequency bridge, whose unbalance voltage, after amplification, produces a graphical record of blood pressure against time. Several new or improved instruments for measuring skin and body temperatures also were reported.

Safety in Servicing Refrigerating Systems

Precautions necessary in blowing down carryover oil from Ammonia Refrigerating Systems

By GEORGE HOLMAN

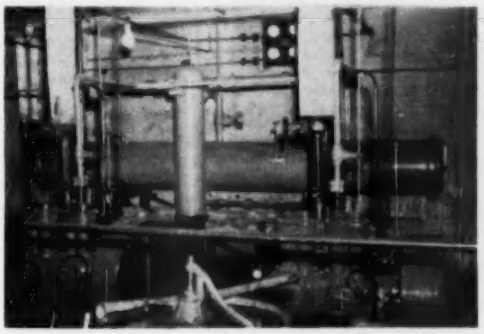
SOME TIME ago I was called to service an ammonia refrigeration system using direct expansion in process work. While I was blowing down oil from a shell-and-tube ammonia evaporator, which had accumulated there by carrying over through the hot vapor line, condenser and liquid receiver because no one had thought to blow down the hot vapor line trap regularly, the managing engineer came up and asked whether or not safety precautions did not dictate that I wear goggles while performing this essential task. "Perhaps so," I replied, after some reflection. "But I can't recall that I ever have."

Thinking over the matter of safety in the operation and servicing of refrigeration equipment, I remembered that less than two years before an ammonia plant operating engineer of my acquaintance had gotten his eye badly burned while blowing down oil. When he opened the blowdown valve, sludge had stopped up the port. The engineer had opened the valve wider and wider. Suddenly the clot stopping the oil flow blew out. Driven by the high vapor pressure, the ammonia-laden oil struck the bottom of his refuse oil bucket and splashed back into his face. The rickety step-ladder on which he stood fell over. Another workman had to use an ammonia mask to enter the room, drag out the injured and half blinded engineer, and return later to close the valve. His eyes badly burned by the ammonia, the engineer spent three weeks in a hospital bed.

Upon hearing of this accident, I had talked the matter over with three other ammonia men. One of these men claimed that the engineer should have blown down the oil through a long pipe nipple or section with the open end submerged in water, a practice he frequently followed. Another claimed that he should have used a temporary blowdown pipe to discharge the oil at floor level or at least some distance from the valve.

The third man pointed out that to blow down the oil the engineer had been compelled to stand on a flimsy stepladder, a hazard in itself, and which, because other equipment interposed, could not be set in the proper position for the engineer to reach the valve. Plant design and unsafe operating and maintenance equipment, like the ladder, were responsible for the accident, this man claimed. None of the three mentioned goggles—or wore them.

In this discussion I voiced my opinion that when the oil failed to come through at the first slight opening of the valve, the engineer should have closed the valve and, since oil blowdown usually is not a pressing duty, awaited a time when he coud pump down the ammonia from that part of the system containing the trap. Or, he could have double-valved the oil out by installing a second valve with a short length of pipe between it and the original blowdown valve. Use of a second valve is good practice, and may be necessary when grit or scale on the seat prevents an oil blowdown valve from seating tightly. One such extra valve may be used on all oil blowdown lines of a system.



This is the scene of the accident described by Mr. Holman

Pointers That Should Be Observed

The following pointers should be observed regarding the blowdown of carryover oil from refrigeration systems:

1. When drawing up plans for a refrigeration system, the designer should consult an ammonia man or operating engineer as to the proper location of oil blowdown valves, and place such valves in a location which permit them to be reached by the operator while standing in a normal upright position on the floor, catwalk, or other safe and secure support.

2. A water cooled oil trap is a much more efficient device for removing oil from compressed refrigerant than one which is not cooled. Although the initial cost is greater, both in purchase price and in installation, the lower temperature of the tube walls permits removal of nearly all of the oil entrained in the vapor. Water may be piped through the trap from any available source, that from the condenser or from the compressor jacket being ideal. This vessel also serves another purpose, that of removing superheat from the compressed vapor and thereby adding heat transfer surface to that of the condenser.

3. An oil sight gage glass on the oil trap helps materially in determining the proper time to blow down oil. If an operator is compelled to climb a ladder, or go into other uncomfortable and out of the way places to try out an oil blowdown valve daily or at other specified periods in plant routine, he is likely to become negligent right at a time a compressor begins to pump oil. This oil may fill the trap rapidly and then carry over into the system to interfere with heat transfer from the condenser, to the evaporator, or to foul expansion valves.

4. Wet compression of ammonia vapor causes greater carryover of oil than does dry compression. For this reason an evaporator being flooded by a mis-set or leaking expansion valve, stoppage of the fan, or accumulation of heavy frost on the pipes or tubes may cause a sudden loss of lubricant from the compressor crankcase to the oil trap and, if not blown down promptly at that point, to the system beyond.

5. Oil blowdown outlets should be kept plugged, but not so tightly as to put undue strain on the valve or other pipe joints when removing the plug under system pressure. When preparing to blow down oil, unscrew the plug slowly with a wrench. When it turns freely, unscrew slowly by hand. If possible, wobble the plug back and forth. If oil foam appears, allow it to dissipate before taking the plug out.

6. When not equipped with a gage glass, an oil trap in a hot vapor line may be tested and the oil level approximately determined by feeling with the hand. If the trap is hot down to the bottom, it contains little or no oil. If it is at or near room temperature nearly to the top, while the compressor is running and the discharge vapor line hot, the trap is full of oil and some may have carried over into the system. A trap cold at the bottom and hot near the top is partly filled with oil. Never

wait until the trap is full before blowing down. Oil should never rise far above the half way mark.

7. Oils commonly used to lubricate ammonia compressors are heavier than liquid ammonia, and usually underlie the refrigerant in the hot vapor line oil trap and other low parts of the system. In some instances, however, an old charge of ammonia in a system contains so much water that it becomes heavier than the oil, and underlies it in oil traps, liquid receivers, evaporators, etc. This writer once found a system with a one-inch band of oil showing atop the liquid in the receiver gage glass. Investigation revealed that the supposedly anhydrous liquid ammonia in the receiver was really a strong aqua, the water having entered the system through a cylinder head from an enclosed water head.

Also, oil, water and ammonia may form an emulsion, which is sometimes distinguished in gage glasses by showing a demarkation line between it and the true oil. Should an operator try to blow down oil under the above circumstances, the consequences could be serious, unless the procedure is carried out alertly and with a full knowledge that all is not oil that is oil-like. If this condition is discovered to exist, the best procedure is to give the oil time to stratify out of any emulsion, or until temperature change clarifies it. Water in an oil-ammonia emulsion is most noticeable when oil is blown from an evaporator. The mixture may then have the appearance of grease gobs, until it warms up to room temperature and begins to flow.

8. If time is available when blowing down oil, pump down the ammonia vapor pressure to about 5 psig. This is ample pressure with which to blow out oil from any trap not closed by a serious sludge stoppage. To attempt to blow out a sludge stoppage by opening the valve wider or by raising the pressure is a highly dangerous practice. It is better to wait for a propitious time, pump out the system, then remove the valve for inspection.

9. If there is no time to pump out the ammonia from a point of blowdown, yet a few minutes can be used, isolate the blowdown valve from the rest of the system by closing off valves. This will prevent the entire charge from being blown out of the system, should the procedure get out of the operator's control.

10. Even though a sight gage glass is used on an oil trap, don't trust it too far. Close and re-open both upper and lower gage valves before making any attempt to blow down the oil. And remember when opening the blowdown valve that the falling oil level in the glass lags behind the falling oil level in the trap proper.

11. Never completely empty the oil trap at any time. Leave some oil with which to seal the outlet while the plug is screwed in, should scale under the seat prevent positive closing of the valve.

12. In each individual system, sound is important, not only the sound of the oil leaving the valve, but also the sound of the oil striking that in a bucket. When oil begins to sputter, the trap or other vessel is almost devoid of oil. Crackling and popping of the oil in a blowdown bucket is caused by the presence of liquid ammonia.

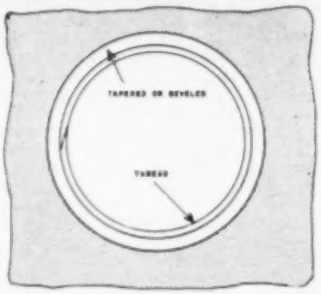
13. Foaming of the oil can be tempered somewhat by using a small quantity of gasoline and water in the bottom of the refuse oil bucket. Water absorbs part of the ammonia and the gasoline reduces the viscosity of the oil.

14. Unless a system is exceptionally clean, it is safer to discard blowdown oil than to take a chance on its re-use. This is especially true of small plants without means of cleaning lubricating oil properly.

15. When blowing down oil, keep in mind everything you know about oil blowdown in general, and in your system in particular. Wear goggles if you have them. But above all, *be alert.*

EASY-STARTING THREADS

WHERE PIPING, plugs or other fittings must be removed and replaced periodically in locations difficult of access, tapering the first thread or two in the threaded opening with a



pipe burring reamer, as shown, will make it easier to engage the starting threads. It may be necessary to partially re-tap the threads after reaming in order to restore the thread contours.

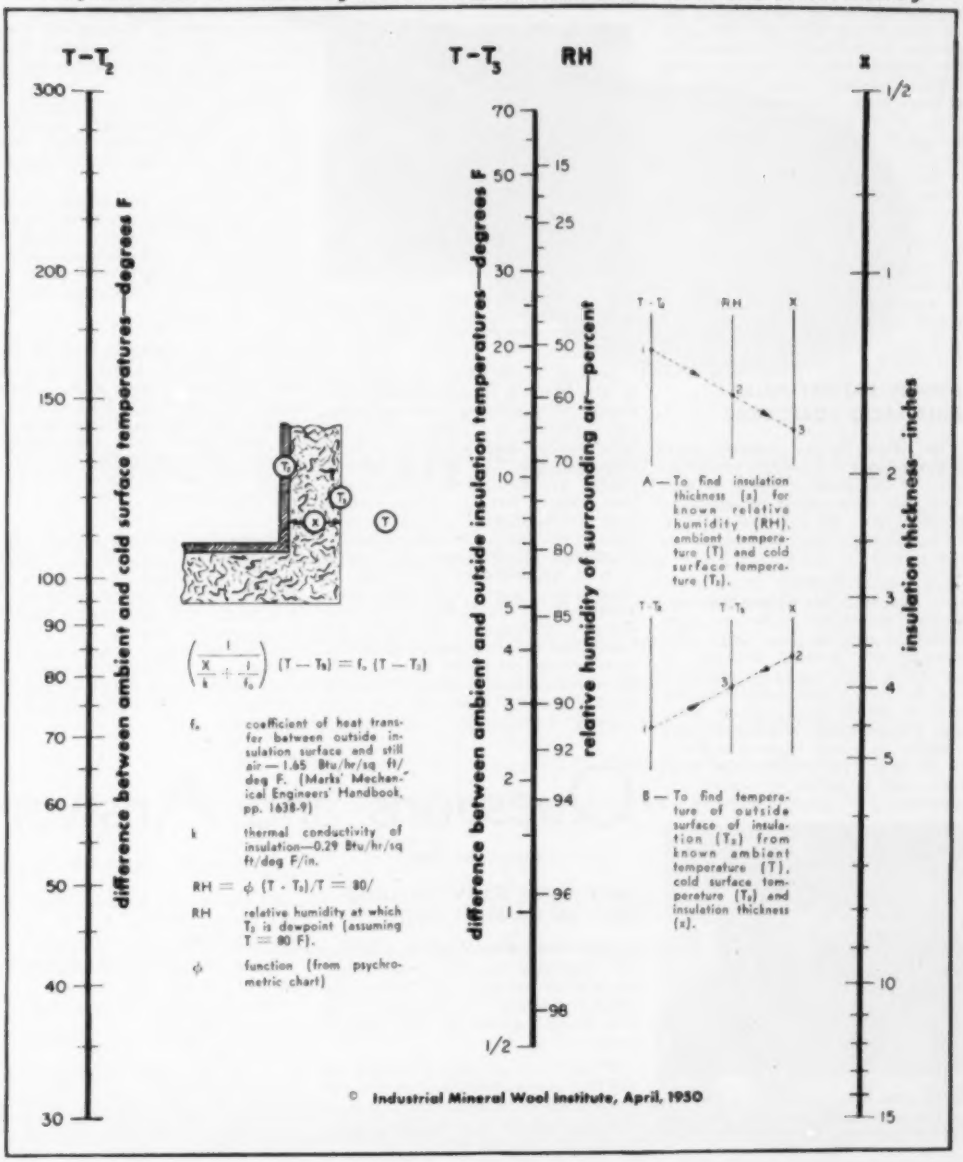
CHART GIVING INSULATION THICKNESS TO PREVENT SWEATING

INSULATION prevents cold-surface sweating on piping, ducts, tanks and other vessels containing cold air or low-temperature fluids—provided the thickness of the insulation is sufficient. The Industrial Mineral Wool Institute has developed a new alignment chart, eliminating guesswork and the use of formulas, on which the minimum insulation thickness that will prevent surface condensation is easily determined.

The temperature (T_2) of the cold liquid or gaseous material in the pipe or vessel, the relative humidity (RH) and the temperature (T) of the surrounding air (as shown in the diagram on the chart) are the conditions at each particular cold surface which determine the minimum insulation thickness which prevents sweating. Because it more than covers the practical ranges of temperature and humidity, the chart (based on K=0.29, an average thermal conductivity for mineral wool insulation) is applicable to any cold surface.

Two examples illustrate how the alignment chart may be used. A sheet-metal duct in an air-conditioning system carries cool air at 48 F through a basement where the ambient temperature often reaches 93 F and the humidity rises as high as 85 per cent. Then $T-T_2$ (93—48) is 45 and RH equals 85 per cent. A straight line drawn through 45 on the left-hand scale ($T-T_2$) and 85 on the center scale (RH) is found

Alignment Chart for Determining Minimum Insulation Thickness to Prevent Cold Surface Sweating



to intersect the right-hand or X-scale at 1½ in.—the minimum insulation thickness required to prevent sweating on the cool-air duct.

In a second example, a tank containing brine at 27 F (T_2) is to be covered with 6-in. thick (X) blanket insulation (as recommended by Commercial Standard CS105-48, "Mineral Wool Insulation For Low Temperatures"). The maximum temperature of the surrounding air is known to be 82F, but the plant manager must know the highest relative humidity that can be tolerated without sweating on the surface of the brine tank. Using the alignment chart, a straight line is drawn through 55 (82-27) on the left-hand ($T-T_2$) scale and 6 (X in inches) on the right-hand scale. The line crosses the center (RH) scale at about 94½ per cent, the highest relative humidity that will not result in sweating. The center scale also indicates that, in this case, the temperature difference ($T-T_3$) between the surrounding air and the outside surface of the insulation is about 1½ F.

STORAGE BATTERY PAINT RESISTS ACID CORROSION

FOR YEARS battery research men sought a paint that would resist the action of the small amounts of acid which may accumulate outside storage batteries. At last the problem of steel battery tray corrosion has been solved.

Sheet steel battery trays were made available just before the war, because in many instances they proved superior to wood trays. For example, the greater strength of steel trays was important, particularly for larger industrial batteries, some of which weigh up to three tons. Furthermore, since steel isn't as bulky as wood, it permitted the use of larger batteries in the same space and provided a neater appearance. The greater strength of the steel trays also eliminated the need for special compartments to house battery installations in electric vehicles. Finally, steel trays were a step toward standardization of the space allotted to batteries and eliminated hand tailoring of wood trays to fit odd dimensions. The result was improved interchangeability and savings to the user. However, to capitalize on these advantages, it was necessary to find a corrosion resistant coating for the sheet steel. Asphalt-base paints, being porous, provided only limited resistance to corrosion. Also under rough usage they yielded too easily to abrasion.

Fig. 1. After three years' service this battery tray painted with asphaltum shows the effects of corrosion. Paint has flaked off in large areas

Fig. 2. This battery tray, protected with Exide's acid-resisting paint, shows no corrosion after two years' service

During World War II, engineers of The Electric Storage Battery Co. began developing a new corrosion proof process to protect aluminum alloy battery compartments in military airplanes. This process not only used a new type of corrosion resistant coating but also a new technique for applying it. Since the new coating protected corrosion sensitive aluminum alloy against the action of acid, experiments were tried on sheet steel coated with the paint. These proved successful, and a number of steel trays, in production for heavy duty motive power batteries, were treated with this process. After several years of use in the field, service reports indicated that this special coating was the answer to the corrosion problem.

The new coating highly resists corrosion, according to Exide engineers. They also claim that if, under unusual circumstances, the surface is scraped exposing the bare steel, corrosion is limited to that area. This is due to the tight bond formed between the coating and the metal surface. As a result, corrosive action can't wedge its way between the two, but is confined to the damaged area.

The bond to the steel tray, as well as other qualities within the coating, are said to enable it to withstand mechanical abuse from blows and abrasion without flaking off. Tests indicate that the new coating holds even when the blow is heavy enough to dent the steel.

Another characteristic claimed for this coating is its high insulating quality. This protects steel trays from corrosion due to the leakage of current.

This new process, which protects steel trays against corrosion, is said to bring users of battery-propelled vehicles important savings resulting from lower maintenance costs and achievement of maximum battery life.

* * *

A LOT OF POWER is packed in a small space in a recently announced electrical cell. Single cells, scarcely larger than ordinary flashlight cells, deliver as high as 100 amperes at 1.4 volts. These cells discharge efficiently at temperatures as low as — 60° F. and as high as + 150° F. —*Ohmite News.*

* * *

A SCIENTIST of the Aberdeen Proving Ground has taken photographs in both color and black and white at an exposure of 100-millionth of a second. It is anticipated that the same camera may be able to take pictures at speeds up to one ten-billionth of a second! The new camera will be used in shock and detonation research.—*Ohmite News.*

Questions and Answers

Answer No. 466

HOW MUCH STEAM DO THESE HEAT EXCHANGERS SAVE?

HOW MUCH STEAM are they saving by reclaiming heat from wash water to heat incoming fresh water, instead of heating it, as formerly, with live steam? asked H.A.W., August issue.

Water in wash boxes heated by 100 psig steam from 100 F to any required temperature

Waste water from boxes to heat exchangers at 150 F

Fresh water to heat exchangers at 58 F

Fresh water leaving heat exchangers at 100 F

Fresh water flow, 1500 gpm

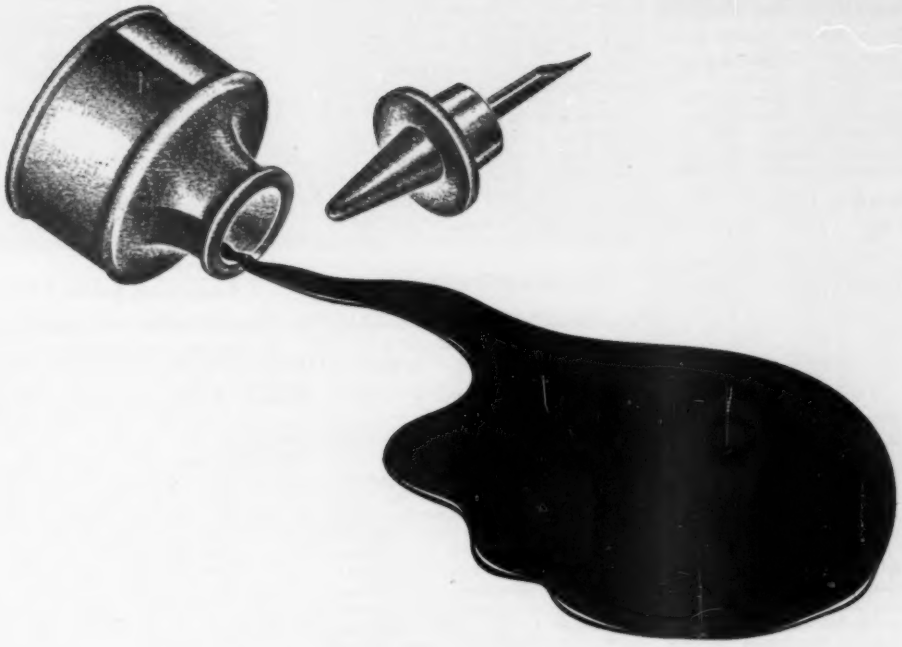
Steam metered at 200 psig, reduced to 100 psig for wash boxes

They have been figuring that

$$\frac{1500 \times 8.33 \times 60 \times 42}{1198.7} = 26{,}400 \text{ lb}$$

per hr of 200 psig steam saved.

Is this the right way to figure it? Several readers pointed out in the September issue that it was not quite right and why.



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Formula Correct But Not Figured Right

IN ONE PART of your question you state that the water is heated by 100 psig steam, and when you figure out the savings you use 200 psig steam. One thing I would like to point out is that the steam tables start at 32 deg F and then you will not extract all of the Btu's out of the steam because the final temperature of the water is 100 deg F leaving the heater or 100 — 32 = 68 Btu that are not extracted from the steam. I will work out the problem both ways.

The following values were taken from Keenan & Keyes *Steam Tables*:

100 psig + 14.7 = 115 psia
115 psia = 1189.7 Btu's
200 psig + 14.7 = 215 psia
215 psia = 1199.3 Btu's

$$\frac{1500 \text{ gal} \times 8.33 \text{ lb} \times 60 \text{ min} \times 42 \text{ deg F rise}}{115 \text{ psia} = 1189.7 - (100 - 32)} = 28071.14 \text{ lb saved per 1 hr}$$

$$\frac{1500 \text{ gal} \times 8.33 \text{ lb} \times 60 \text{ min} \times 42 \text{ deg F rise}}{215 \text{ psia} = 1199.3 - (100 - 32)} = 27832.93 \text{ lb saved per 1 hr}$$

Your formula was correct but your values were not figured correctly.

Parma, Ohio — AL KELLING

He Didn't Use Correct Enthalpy Value

I BELIEVE that H.A.W. is slightly in error with the formula he proposes. The denominator of his equation states "total heat of steam . . ." By definition, the total heat of steam is the heat that may be extracted from the steam when it is condensed and cooled to 32 F. If it is cooled to any other temperature, the heat content of the water at the temperature in question must be subtracted from the total heat of the steam. In this case the fresh water leaves the heat exchanger at 100 F, which is the equivalent of putting sufficient live steam into the fresh water to heat it to 100 F. Therefore the value for the total heat of water at 100 F should be subtracted; this value is 67.9 Btu per lb.

He states that "saturated steam at 100 psig" is used to heat the wash water. This means to me that there is a reducing station with a downstream pressure of 100 lb, and then sufficient run of pipe to desuperheat to 100 psig saturated steam. When the old operation was in force, steam equivalent to the heat loss was wasted. It is therefore proper to base a steam saving calculation on the heat content of 200 lb steam, even though the wash water was fed with 100 lb steam.

The equation then becomes:

$$\frac{(\text{Gpm fresh water})\ (8.33)\ (60)\ (\text{Deg F rise in temp})}{(\text{Total heat of steam at 200 psig} - \text{Heat of water at 100 F})} =$$

$$\frac{(1500)\ (8.33)\ (60)\ (42)}{(1198.7 - 67.9)} = 27{,}900 \text{ lb steam saved/hour}$$

This represents an increase of 5.7% over the previous figure.

Niagara Falls, N. Y. — J. I. LACEY

Answer No. 467

HOW CAN HE LIMIT DUPLEX PUMP SPEED?

WHAT SORT of device could he use, asked F.L.S., August issue to limit the number of strokes per minute of duplex steam pump?

A number of readers recommended a well-known pump speed governor, the operation of which was described in some detail in the September issue.

Here's the way another reader would do it.

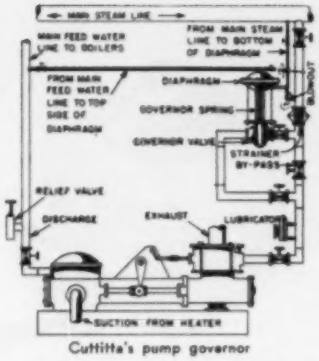
How Governors Are Used by Cuttitta

THE QUESTION does not mention what the duplex pumps are used for. So may I assume they are being used for feed water purposes. So I'll go along on that assumption.

Here at our plant we have a few duplex feedwater pumps that have served us well for over a half a century. They are equipped with steam control governors, and can be adjusted to any desired speed so designed for, once our maximum and minimum feedwater supply was established for the various seasons, it was seldom necessary to adjust them again.

A big MUST should be remembered in the installation of steam control governors. That is to install a pressure relief valve on the discharge end of said pumps, as a safety measure to guard against accidentally shutting off the boiler feedwater valves. These steam control governors have not only proved successful in operation, but efficient and inexpensive to maintain.

Fairlawn, N. J. — A. F. CUTTITTA



Cuttitta's pump governor

Use Pump Speed Governors, says Lacey

WE HAVE two duplex steam pumps in service, both are used in chemical manufacturing processes under varying discharge pressures. They are both equipped with pump speed governors as described in the October issue. One pump is a 6 x 5¾ x 6, it has a size No. 1. The other is a 14 x 6 x 12 with a size No. 2. These governors have proved very satisfactory on what we consider a difficult installation.

This governor throttles the steam supply to the pump to maintain a constant stroke per minute speed. If the speed of the pump varies for any reason, the governor will change the steam admission to bring the pump back to the set speed. The set speed may be varied by a simple adjustment on the governor.

Niagara Falls, N. Y. — J. I. LACEY

Answer No. 468

WHAT IS RATE OF CONDENSATION PER SQUARE FOOT OF STEAM COIL?

Lacey Calculates Condensation Rate

IT IS DIFFICULT to give V.L.G. an accurate answer because he does not describe the condition of the water around the coil. If the water is moving over the coil rapidly, as when it is pumped or agitated, the rate of condensation is quite a bit higher than when the coil is set in calm water. Also calm water will allow the coils to silt up more rapidly than moving water. The example given below assumes the two extreme conditions, V.L.G. will have to decide which case is his or if it lies in between.

In any event, the formula $R = (U\ t)/(Hs - Hc)$ will hold, where:

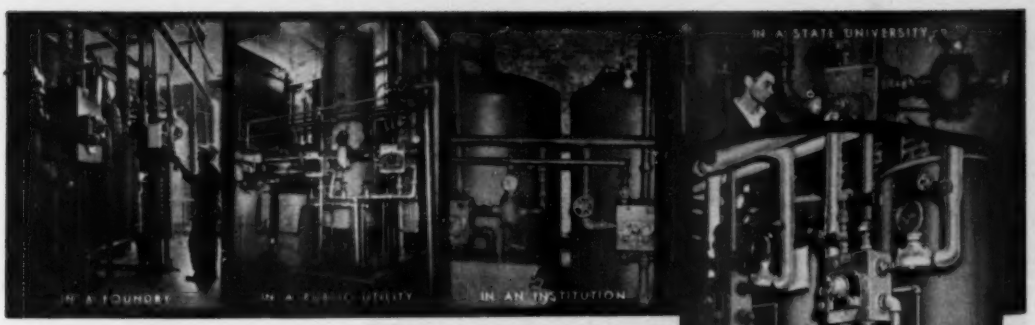
R = Rate of condensation in pounds of steam per hour per square foot of coil (outside area)

U = Over-all heat transfer coefficient. For agitated water use 80 and for still water use 20 Btu/hr × ft × F

t = Temperature difference between steam and water. Here t = 358.4 — 60.0 = 298.4 F.

Hs = Total heat content of steam, from steam tables = 1194 Btu per lb

Hc = Total heat condensate, measured at the temperature it



THE FLEXIBILITY OF THE COCHRANE ZEOLITE SOFTENER PLUS THE SIMPLICITY OF THE HYDROMATIC VALVE MAKE THIS THE IDEAL SOFTENER FOR YOUR NEEDS

A wide range of zeolite materials is available with Cochrane equipment and Cochrane will recommend the type best suited for your particular problem. Siliceous and Non-Siliceous zeolites are available. The siliceous include low and high capacity greensands and the synthetic gels. Non-siliceous include the coalbase type and phenolic and styrene resins.

COCHRANE ZEOLITE SOFTENER with the HYDROMATIC SINGLE CONTROL VALVE

The Cochrane Hydromatic Single Control Valve combines, in a single pilot-actuated valve, the functions of six individual gate valves common to the customary "valve nest". May be arranged for manual or automatic operation.

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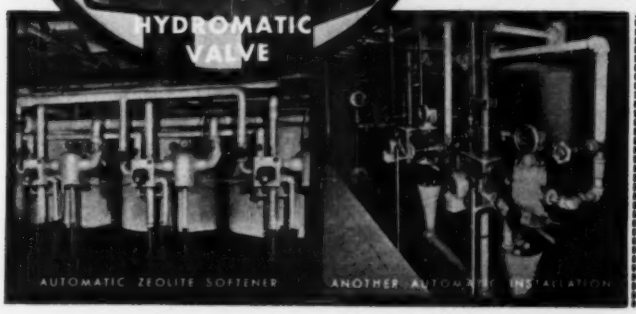

Write for a copy of this new booklet on the Cochrane Zeolite Softener, with the Hydromatic Valve.

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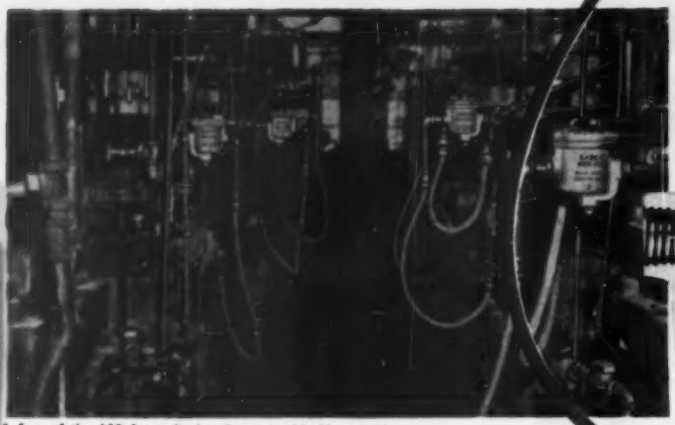
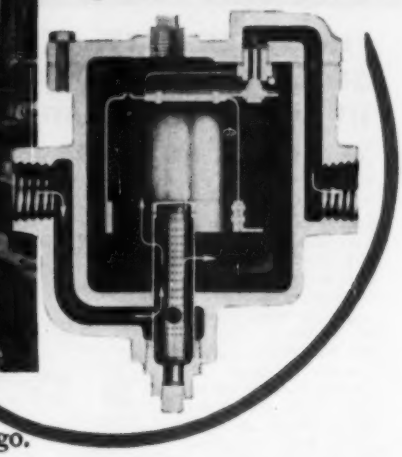


A few of the 100 Sarco Bucket Traps in this Plastics Plant



Here's a "test" to end all tests as far as steam traps go. More than 100 Sarco Bucket Traps in operation 24 hours a day most of the time for more than 15 years! As the manager of this plastics plant puts it "They are tops in satisfaction—what more can I say." And the mechanic who put them in and has had charge of the steam service for 22 years, says "Sarco ended our trapping problems 15 years ago."

IT COSTS LESS TO BE RIGHT — The invariable result of adding Sarco Steam Traps and Temperature Controls to improve production is a *saving in fuel costs*. Heat where you want it, when you want it — never too much — or too little or too late. To be right the first time see Sarco first.

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SARCO Bucket Steam Trap clears condensate instantly. And it costs less to install because of the built-in strainer (at no extra cost) and the straight-thru connection which saves piping materials, time and labor. Ask for Catalog No. 350.

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leaves the coils. In this case, assume the condensate is cooled to 200 F in the coil. From the steam tables = 168 Btu per lb

For the case of agitation the answer then becomes:

$$R = \frac{(80)\ (298.4)}{1194 - 168} = 23.3 \text{ lb per hr per sq ft.}$$

For the case of still water the answer then becomes:

$$R = \frac{(20)\ (298.4)}{1194 - 168} = 5.83 \text{ lb per hr per sq ft.}$$

Niagara Falls, N. Y. J. I. LACEY

Answer No. 469

HOW CAN HE FIND GROUNDS ON A 32-VOLT CIRCUIT?

Use Ground Lamps, says von Dannenberg

TO BEGIN WITH, if it has not already been done, ground detecting lamps should be installed at the control panel or point of supply. These are indicated on appended connection diagram as L + and L — assuming d-c generation; if it is a one-phase

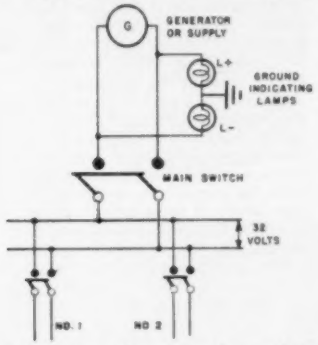


Diagram by von Dannenberg showing detector for grounds on 32-v circuit

supply, the connections will remain the same. These may be mounted on the control panel or at any convenient point readily in view; and, as shown, should be connected between the generator or source and the main switch; keyless wall receptacles using lowest-capacity 32-v lamps easily visible should be used.

It will be noted from the diagram that if one line develops a ground between the main switch and a circuit point the lamp connected to the other line will have its voltage to ground increased and if a "dead" or complete ground will receive full voltage and glow at full brilliancy the other lamp being dark. Ordinarily each lamp receiving only one-half voltage will show only the slightest filament glow.

When a ground is indicated, the circuit at fault is located by opening the circuit switches one at a time until the ground clears, as indicated by the ground indicating lamps returning to the normally dark condition. The diagram indicates only two feeder circuits although the procedure is the same regardless of the number.

If the ground continues to indicate after all circuit switches have been opened and closed, the main switch should be opened and, if the ground continues, the ground is in the supply equipment, generator or transformers, or its connections and must be looked for in this portion of the installation.

If found to be in the supply equipment itself, it may even have to be removed for repair and dismantled after testing to determine the fault location. Equipments installed on motorboats in salt water service are subject to this trouble.

If the fault is located in one of the circuits fed, its actual point can only be determined by inspecting each piece of equipment connected. If the ground is found to be in the wiring or in a portion enclosed in conduit, it can only be located by using other methods. If the ground is a positive one, a reversing d-c current applied to the section will cause a compass to swing until the fault point is passed, when no needle swing continues. There is equipment available on the market such as the Matthews Telefault and similar apparatus operating on this principle, but it is somewhat expensive to purchase unless the 32-v system is extensive enough to warrant the purchase of such testing equipment.

The most difficult faults to locate are those of an intermittent "on and off" type and will tax the time and patience of the investigator.

Brooklyn, N. Y. C. O. VON DANNENBERG

Answer No. 471

SHOULD THE SUCTION PRESSURE COME DOWN TO ZERO ON THIS CO_2 COMPRESSOR?

IN THE SEPTEMBER issue, E.B. said it didn't when he shut down his CO_2 compressor. Also he described some other actions of the various pressures that he couldn't explain to himself. The answers are fairly simple, indicating that all the difficulties are caused by valve leakage. Yes, says Whyte, the suction pressure should come down to zero if all valves are holding.

Whyte Answers Each Point

IN ANSWER to this question, I would venture to answer each step as follows:

1. Closing expansion valve and still having 200 psi on suction while the machine is running.

Answer: Expansion valve must be wire drawn on seat and leaks this volume through when shut off.

2. Closing suction valve.

Answer: This valve is also leaking on seat but at only half the volume of expansion valve.

3. Should the suction gage reading come down to zero?

Answer: Yes. If both the expansion valve, suction valve and all discharge valves are holding.

4. After the compressor is stopped and before discharge shut off valve can be closed, suction gage registers 350 psi.

Answer: Discharge valves on machine not holding tight at seat, or gasket, between valve body and compressor jacket, which will cause equalization of 700 psi after standing idle for 2 days, which is half of 950 psi plus 450 psi, as indicated when the machine is in operation.

Chicago, Ill. FRED WHYTE

LETTERS TO THE EDITORS

(Continued from page 53)

the article, the viscosity can be from 150 to 800 seconds. From 150 to 300 seconds, it *may* be possible to obtain efficient combustion, but above that viscosity, difficulty can be expected without preheating.

When operating without heating, the weather will be a decided factor. Warm weather will make the oil fluid, whereas at low temperatures the viscosity increases. This increase will vary with the different types of oils.

To properly burn fuel oils, the viscosity at the burner should be from 100 to 200 seconds Universal. This is necessary to obtain the fine spray or atomization necessary to completely burn the oil.

As noted in your letter, you have experienced some difficulty, which you believe is due to the viscosity. This is probably true, due to two reasons.

First, most No. 5 oils are blended from a No. 6 oil by adding light oil. Sometimes the proportions are not correct.

Second, the method of blending is often very inadequate, resulting in some blended and some unblended oil. If this mixture is pumped into a storage tank, the oil may have a viscosity of 100 seconds on the top, 300 in the middle and maybe 800 on the bottom, which will give a very inconsistent type of oil to the burner. These two factors can mean oils of many viscosities from the same or different source.

There is not more difficulty in burning No. 5 oils than No. 6, but when using No. 6 oil, you generally have enough preheat equipment to handle *anything*, while if using No. 5 oil, your equipment may be limited. The viscosities of No. 6 oils will vary as much as No. 5 oils.

An article entitled, "Preheating of Fuel Oils," will be published in POWER ENGINEERING, as No. 12 of the series, some time in the future.

PAUL F. SCHMIDT,
Chemist,
Allied Oil Co., Inc.

19th Power Show Will Feature Advanced Power Plant Design Standards

ADVANCED STANDARDS of design applied in modern power plants will be featured by the more than 300 exhibitors at the 19th National Exposition of Power and Mechanical Engineering at Grand Central Palace, New York, November 27 to December 2. The Exposition, popularly called the Power Show, will be held under the auspices of the American Society of Mechanical Engineers, coincident with the annual meeting of the Society, which is strongly committed to progress in engineering through standardization of improved materials and codes of safe practice.

Of greatest interest to business executives, industrialists and engineers who make up the principal audience, will be equipment which directly reflects the forward trend in generating plants, much of which is specified for units now under construction or presently planned by the great power-consuming industries and forward-looking public utilities. Equally important in the view of many visitors is the application of much of the equipment on display to existing plants. In many instances, modifications now possible for the first time will raise efficiencies to levels that were literally out of sight only a few years ago.

Advanced standards of design will be reflected in exhibits at the Power Show, notably in improved methods and equipment for treating fuel before it enters the combustion chamber, providing wider latitude in the selection of fuel and improved extractions of its heat. Exhibits showing advances in this field include grates, fire-boxes of new design and refractories of improved durability. There are also more efficient power oil burners, blowers, draft equipment, smoke prevention equipment which not only allays a nuisance but improves efficiency by reinjecting into the fire the unburned hydrocarbon particles which darken the products of poor combustion.

Many owners and operators of large and small power heating plants have awakened to the need for modernization of their equipment as new smoke and fume abatement rules begin to take effect. Higher working efficiencies result immediately from the change-over to improved apparatus, stimulating interest over and above the legal requirement.

Apparatus particularly appropriate to the problem of smoke suppression, a live issue in many communities, include oil and coal handling equipment, piping, pumps and burners; grates, fire walls and insulating materials, stokers, draft equipment, fire and draft controls.

Smoke indicating instruments, of which there will be several displays, are recommended equipment for all stationary boiler plants, so that the fireman or operator can know at all times the shade or appearance of any smoke emission from the stack.

General view of National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York

Dust-Collecting Equipment

One group of exhibits will consist of dust-separating equipment, which also is recommended for all new installations of pulverized-coal-burning equipment, spreader stokers or similar suspension burning types. Dust separators may be of several types, such as settling chambers, baffle collectors, electrostatic collectors and several types of centrifugal collectors.

Centrifugal collectors of a new type utilize the inertia of the dust particles in conjunction with the aerodynamic forces in the draft to produce a highly efficient separation through a series of very fine louvers in a cone-shaped filter element.

Engineering Materials

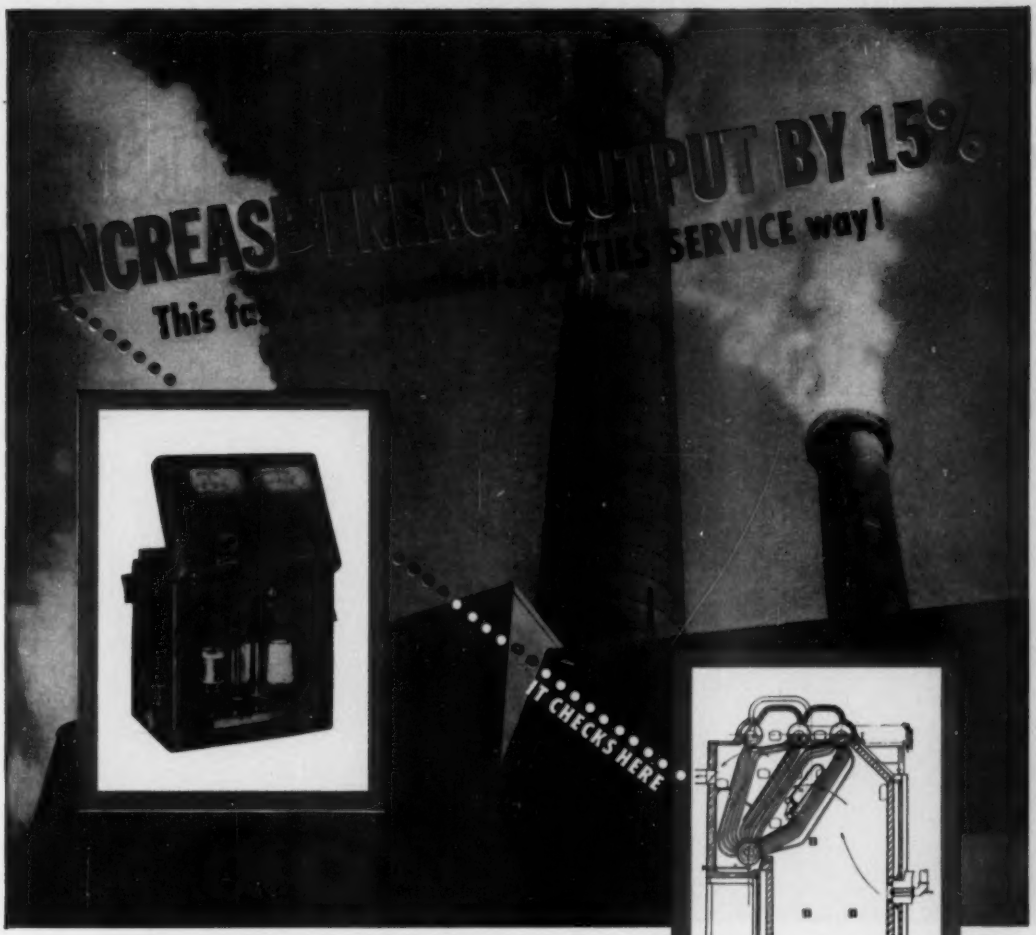
Engineering materials in the raw will be displayed, in fabricated forms and in finished products to meet the most exacting requirements of resistance to pressures and temperatures far beyond the demands of the past. Many of these are produced by methods that have come into commercial use within only a few years.

A most important group of copper-base alloys used in condenser tube applications is composed of the "inhibited Admiralties," an outstanding application of which is found in condenser tubes. An example to be seen at the Show is a demonstration condenser of the shell and tube type in which phosphorized Admiralty tubes are used that are extruded from continuously-cast billets. This exhibit is designed to demonstrate visually some important characteristics of fluid flow in heat exchangers of this pattern, and is distinctly educational in its nature.

Educational Displays

Numerous displays have been developed especially for educational purposes. One such, broadly covering the need for higher standards in the design of heat exchangers, will be staged by the Tubular Exchanger Manufacturers Association. At another booth a typical pressure-loss testing hook-up, counterpart of laboratory equipment used in valve design, will be seen. This equipment demonstrates comparative flow characteristics, using half-section models of conventional and streamlined valve bodies, emphasizing the superior opening action and lower pressure-drop of newly developed

(Continued on page 128)



The Cities Service Industrial Heat Prover

This remarkable instrument is an exhaust gas analyzer, designed for use on industrial furnaces regardless of size or type. It is provided with three scales; one shows per cent of oxygen, another percentage of combustibles present and measured in the flue gas sample, and the third scale registers flue gas temperature.

A fuel analysis taken at this important checking point—during a free demonstration—has led to increases in energy output as high as 15%. The Heat Prover indicates the type of adjustments necessary to get maximum combustion efficiency.

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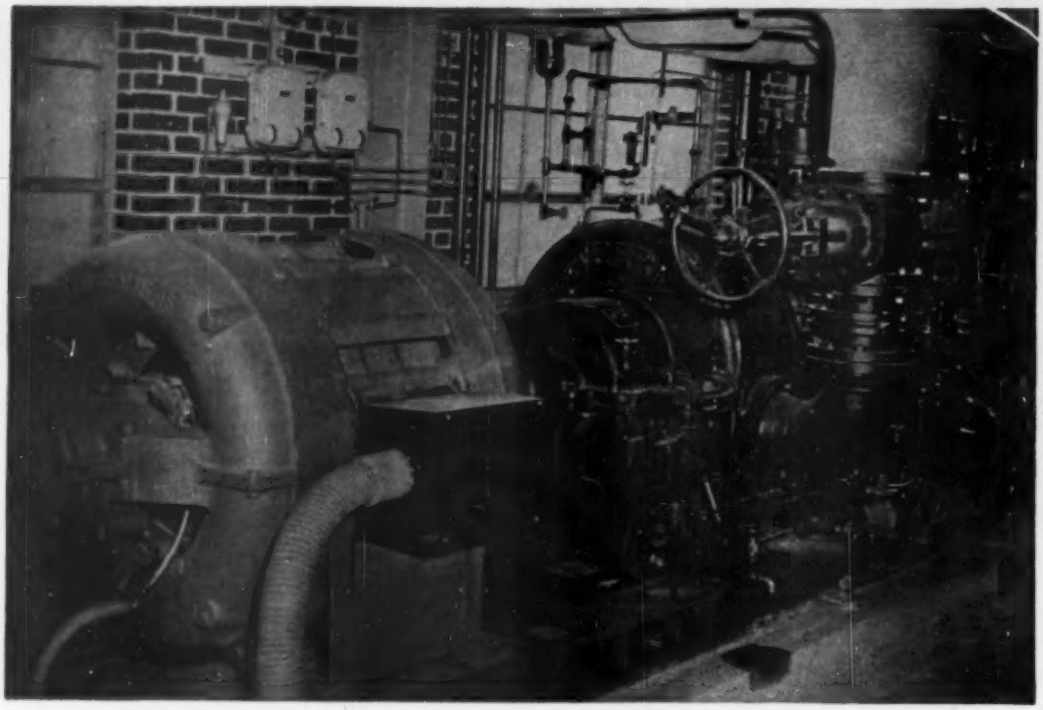

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This 200 kw Terry Turbine driven generating unit operates in parallel with other generating equipment, the load on the unit being adjusted in accordance with the demands for exhaust steam. It is a single stage axial-flow, type, 4500/1200 rpm, 160 psi, 0 superheat, 5 psi back pressure, equipped with Terry reduction gears, oil-relay governor, motor synchronizer and back-pressure regulator.

The installation pictured above is typical of many special applications of Terry Steam Turbines, each designed for specific requirements.

Any of our district representatives will gladly give you full information on a turbine to meet your requirements, no matter how special they may be.

No obligation, of course.

T-1176

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FIGHTIN' WORDS? Well, not exactly . . . but certainly a frequent cause of dispute in the front office as well as in the boiler room! Which method is the most practical . . . the most efficient . . . the most economical?

There is no general rule that can be followed. Present-day practice says "External treatment is often desirable—but internal treatment is always necessary." However, every case is different and must be considered on its own merit. That's why so many engineers depend on the Drew System of Water Treatment for the correct answer.

The Drew System of Water Treatment eliminates guesswork! It starts with proper diagnosis. It includes recommendations for corrective treatment and other preventive measures such as modification of operating cycles and redesign of equipment, if required. It is specialized service applied to your individual boiler problem.

Don't gamble with guesses! Consult the Drew Engineer or write for further information.

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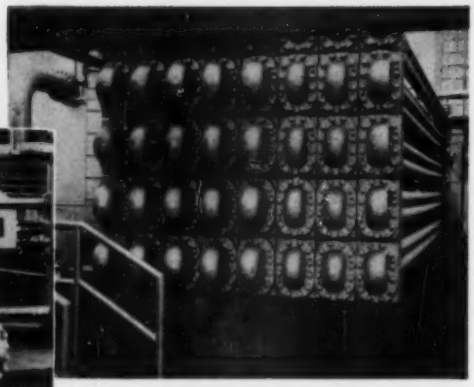
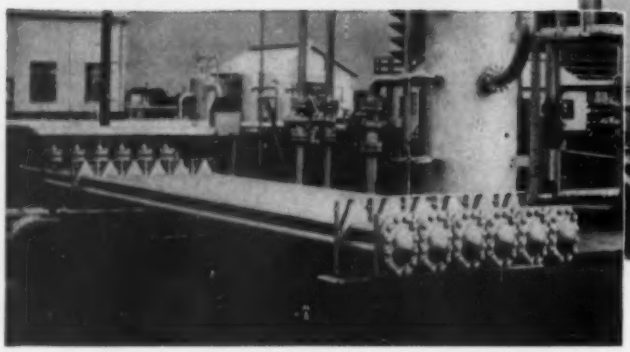
Compelling Reasons
Why You Should Investigate
G-R TWIN G-FIN SECTION





Two installations of G-R Twin G-Fin Sections arranged in parallel (at left) and in series-parallel (above). At upper left: cut-away view of Twin G-Fin Section.

If your plant requires a heater, cooler or heat exchanger, consider the record of the G-R Twin G-Fin Section. Here is a heat transfer apparatus that is:

SIMPLE . . . it consists essentially of one pipe within another, without the complications of tube sheets, baffles, or internal joints.

EFFECTIVE . . . the patented longitudinal G-Fins on the outside of the inner pipe provide an extended surface that compensates for the unequal heat transfer rates of dissimilar fluids such as oil and water or steam and process liquids.

ECONOMICAL . . . it is a stock design, easily installed, sturdily built for long life, requiring no attention, with negligible maintenance expense.

ADAPTABLE . . . units are standard and interchangeable, can be made of either ferrous or non-ferrous metals or alloys, can be used as a heater, cooler, condenser or heat exchanger for practically all liquids, vapors and gases, and can be readily converted from one service to another.

These advantages have been proven by installations totalling more than 50,000 units during the last 16 years, serving a greater variety of heat transfer requirements than any other design on the market. Most likely a G-R Twin G-Fin Section will improve one or more heat transfer operations in *your* plant. Write for Bulletin 1614 describing these units in detail.

50,000 INSTALLED UNITS
16 YEARS OF PROVEN PERFORMANCE
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Gives ALL THESE PLANT SAVINGS:

1. **Extends TIME between greasings**—lasts longer . . . stays in bearings longer.
2. **Low-cost application**—fewer servicings and *only the one grease* to handle.
3. **Simple inventory**—Shell Alvania Grease replaces up to 20 brands formerly required.
4. **Better protection**—against heat, cold and moisture.
5. **Greater safety**—less chance of applying the wrong grease!

Gives ALL THESE LUBRICATION ADVANTAGES:

1. **Higher mechanical stability** than any conventional grease at operating temperatures.
2. **Pumpable at low temperatures**—even in unheated storage.
3. **Stable at high temperatures**—superior to the best "soda" greases.
4. **Impervious to water**—excellent resistance to washing out.
5. **Longer service life**—reduced consumption.

The "MILLION-STROKE" Industrial Grease!

A grease that will stand 100,000 punishing strokes of the ASTM Work Tester has been considered a superior lubricant.

In a deliberate attempt to break down Shell Alvania Grease, *on the same tester* the run was extended...200,000 strokes...300,000 strokes . . . 500,000 strokes! Finally, at one million strokes the test was discontinued, because this grease *would not break down*—it was still a fit lubricant both in appearance and consistency.

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S32 ROTOJET Junior Air-driven Motor, universal joint, cone cutter.

C439 ROTOJET Junior Air-driven Motor, universal joint, drill head

C434 ROTOJET Junior Air-driven Motor, flexible coupling, expanding brush.

C324 ROTOJET Junior Water-driven Motor, univ. joint, pivot head

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New ENGINEERING BOOKS

Author's Guide for Preparing Manuscript and Handling Proof; 80 pages; illustrated; size 6½ by 9¼ in.; cloth binding; published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y.; Price $2.00.

This book is a completely rewritten version of a former book entitled The Manuscript: A Guide for Its Preparation. In The Manuscript, the emphasis was on that document, but in this rewritten version, entitled Author's Guide, the emphasis has been shifted from the manuscript to its writer. The guide now serves as a start-to-finish manual on the most efficient methods of preparing and handling manuscripts, illustrations and proof. It also shows the author how his manuscript progresses from its first stages to the printed book.

Although an author will not have contact with all the publisher's staff and procedures used in producing his book, still the more he understands of these processes the better able he will be to carry on his own part.

For all engineers who attempt to write either technical articles or technical books, this guide will be a very valuable help for it is primarily aimed at the technical writer. The publisher is one of the leading producers of technical books in this country.

The book takes up first the details of preparing the manuscript for the publisher, such as its form, the way in which it should be marked for type, headings, editorial style and other details.

Chapter 2 is a very detailed and clear discussion of preparing the illustrations for the publisher.

Preparing the material for the printer and draftsman is discussed in Chapter 3, while Chapter 4 gives instructions for checking engraver's proof, cut dummy and galley proof. Chapter 5 shows you exactly how to read proof. Chapter 6 takes up completing production. Chapter 7 formal publication and copyright and Chapter 8 preparing for reprints and new and revised editions.

An appendix gives many details of editorial style used in technical writing, showing the importance of correct abbreviations, references, numerations, punctuation, compounding of words and similar details. At the end of the book is a glossary of editorial and publisher's terms and the book is well indexed.

Every engineer who has ambitions to write technical material, especially books, should study this guide carefully.

• • •

1949 Book of ASTM Standards published by the American Society for Testing Materials; 6 volumes covering subjects as listed below; 8000 pages; illustrated; size 6 by 9½ in.; cloth binding; published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; price Parts, I, V and VI—$10.00 each, Parts II, III and IV—$8.00 each, complete set of six parts—$54.00 per set, for half leather add $2.00 for each part.

This is the latest edition of this important book representing the work of literally thousands of engineers, working for and co-operating with the American Society for Testing Materials. These men, the leaders in their respective fields, have prepared the more than 1550 standards, specifications, tests and definitions for materials included in this book. It is used not only in the United States and Canada but throughout the world for purchase of materials and particularly for evaluating their quality through the standard tests that are given.

It seems to this reviewer that a company manufacturing any products for the engineering field can scarcely get along without consulting these ASTM Standards at frequent intervals. They certainly should be on the shelves of every industrial plant in the country so that they will be available to the purchasing agent, the power engineer, the plant engineer and everybody else who has to specify and test material.

Each part of the 1949 book is complete with detailed subject index, two tables of contents and is arranged to be as usable as possible. To keep the books up to date, a supplement will be issued to each part late in 1950. There is a complete index to standards which is furnished without additional charge. Part I, Ferrous Metals, is

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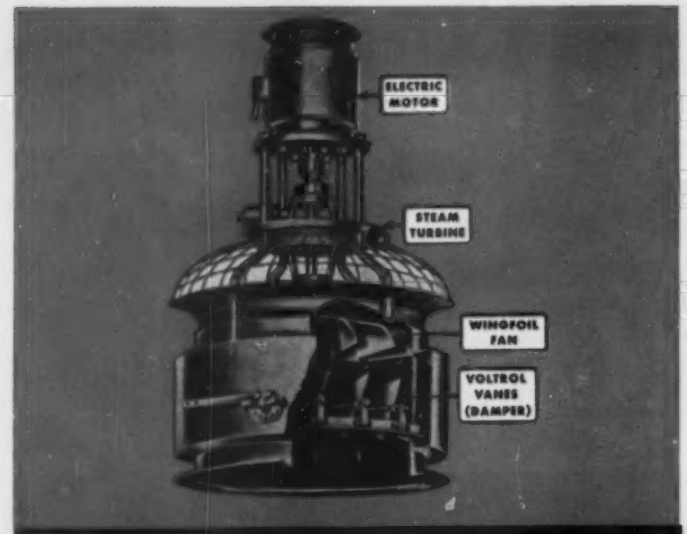

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With the new Wing Dual Drive Forced Draft Blower you can alternate between turbine and electric drive. Your choice of drive may be governed by consideration of heat balance, of economical operating cost, or by an emergency affecting the source of power. All you have to do is throw a switch to operate the motor or turn a couple of valves to change to turbine drive! There is no harm to either motor or turbine when one or the other is idle. A wide range of control is possible in both motor or turbine drive. Throttling gives adequate control with turbine drive and the Wing Voltrol Vanes (capacity regulating dampers) permit capacity regulation when constant speed motor is driving. Automatic operation may be arranged with combustion-control system. The unit is extremely compact and may be adapted to either vertical or horizontal discharge. Installation is simple, easy and economical. It is shipped completely assembled and aligned, ready to bolt to the foundation.

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the most widely distributed part of the Book of Standards. It contains 1400 pages and about 275 specifications and tests of which about 180 relate to steel and steel products. These cover both carbon and alloy steel, structural shapes, reinforcement material, finished bar, sheet and strip and the entire range of steel products. It also covers wrought and pig iron and castings, ferro alloys, magnetic materials and general testing methods for all steel products.

Part II on Non-Ferrous Metals covers aluminum, magnesium, copper and their alloys, pipe and tubes of these materials, lead, nickel and lead alloys, solder and bearing metal, zinc, electrical-heating and resistance alloys, metal powder products and electro-deposited coatings. Here, too, general testing methods for all these items are described.

Part III covers cement, concrete, ceramics, thermal insulation, road and waterproofing materials and soil. All the materials widely used in constructions such as cement, brick, structural tile, masonry, insulation, refractories, roofing and waterproofing materials and the like are discussed in detail.

Part IV covers paint, naval stores, wood, adhesives, shipping containers and paper.

Part V covers textiles, soap, fuels, petroleum, aromatic hydrocarbons and water, including general testing methods and a full discussion of coal, coke, industrial water, gaseous fuels and thermometers.

Part VI covers electrical insulation, plastics and rubber.

This book is an excellent example of the valuable results that come from the intensive work of the many members of the Society and its active technical committees which, as noted above, include leading engineers and technologists in every field. It makes available to everybody the details of materials and testing methods that have been such an important factor in raising our American productive system to its present high peak of effectiveness and capacity.

Obituaries

J. N. HUNTER

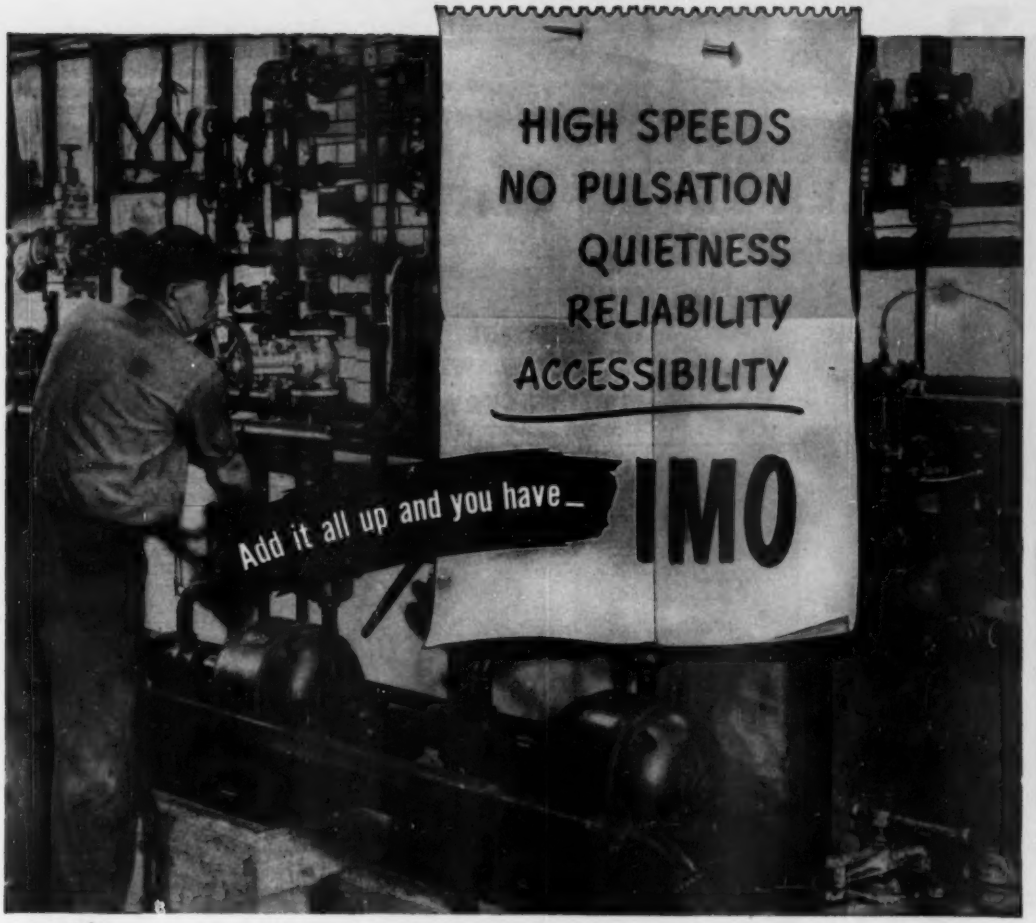
J. NELSON HUNTER, purchasing agent of Combustion Engineering Corporation, Ltd., of Canada, passed away suddenly on August 24 at the age of 59. A native of Northern Ireland, he came to the United States in 1913 and two years later became associated with Combustion Engineering Co. in New York, later spending two years with the Royal Flying Corps during World War I. When the Canadian Co. was formed in 1923, he was transferred to Toronto as chief draftsman, and subsequently to Montreal as purchasing agent, where he was widely known to Canadian engineers.

DR. ROBERT ERNEST DOHERTY

DR. ROBERT ERNEST DOHERTY, who retired from the Carnegie Institute of Technology presidency in July of this year, died last night in Scotia, New York, at the age of 65.

During his 14-year tenure at Carnegie, Dr. Doherty made one of the greatest contributions of this century to undergraduate professional education in his creation and development of what has since become known as the Carnegie Plan. This Plan, now proved but still revolutionary, brought national attention and prestige to both Dr. Doherty and his institution.

In addition to his educational pioneering, Dr. Doherty more than



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The IMO can be direct-connected to high speed motors or turbines; it requires no reduction gearing; occupies but little space; and operates smoothly, quietly and efficiently.

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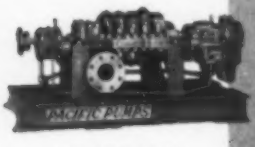
PACIFIC TYPE IBF



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WBF	11 Pumps	47,700	259F	710
ABF	3 Pumps	220,000	281F	1114
	3 Pumps	300,120	286F	1304
IBF	3 Pumps	433,000	316F	1822
	3 Pumps	493,000	306F	1619
JBF	3 Pumps	165,000	260F	490
	1 Pump	117,500	250F	775

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doubled the Carnegie endowment and carried through major administrative reorganizational programs.

As a citizen of Pittsburgh, he was one of the small group of men who started the now nationally acclaimed civic and cultural rebirth of the city. Dr. Doherty proposed and was one of the founders of the Allegheny Conference for Community Development, the guiding force behind Pittsburgh's new growth.

BURT C. TAYLOR

BURT C. TAYLOR, Vice-President and Treasurer of The Dayton Power and Light Co., died suddenly at his home, 4300 Southern Boulevard, Dayton, on October 13. Mr. Taylor was born in New Carlisle, Ohio, on April 25, 1896. He spent most of his early life in Arcanum, Ohio.

He started work for The Dayton Power and Light Co. as a messenger boy on April 1, 1911, when he was just under 15 years of age. From that time on his energies and talents won him constant promotions in the Accounting Division of the company. On April 29, 1937, he was named treasurer. He was elected vice-president on May 12, 1938, and selected as a member of the board of directors on May 14, 1942.

EARLE S. HENNINGSEN

EARLE S. HENNINGSEN, retiring manager of engineering of General Electric's Large Motor and Generator Divisions at Schenectady, N. Y., died September 23 at Easton Memorial Hospital, Easton, Md., after a brief illness. He was 60 years old.

A pioneer in the development of alternating-current machinery, Mr. Henningsen was to have retired officially October 1 after 38 years' service with G. E.

Following graduation from the University of Wisconsin in 1912, Mr. Henningsen joined G. E.'s Test Course for student engineers at Schenectady. He became head of the test program in two divisions, and in later years played a prominent role in the training of engineers for a variety of assignments in many phases of the Company's work.

In 1926, he was given mechanical design and administrative responsibility for G.E.'s A-C Engineering Department, and was made engineer in charge of the department in 1930.

Mr. Henningsen designed the first commercial machine to be cooled by hydrogen, and developed the laminated segmental floating rim for large waterwheel-driven generators. This general method of rotor construction completely replaced castings for this type of generator and is in general use in industry today. He also helped devise the first spring-supported stator frame support for single-phase generators for railway power, a construction later applied to vertical waterwheel-driven single-phase generators.

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BOLTED BONNET
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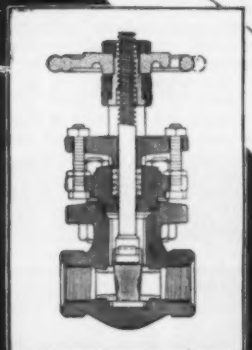
150-800 POUND

GATE VALVES

SIZES 1/4" to 2"



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CARBON STEEL } 800 Pounds @ 750° F.
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For 150-800 pounds service • Round Bolted Bonnet • Bolted Gland • Gasket or Ground Joint • Outside Screw and Yoke • Renewable Seat Rings • Solid Wedge — Slotted Type • Rising Stem 11½-13% Chrome Stainless Steel Trimmings • Sizes 1/4" to 2" inclusive.

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Packaged Boilers Deserve Good Fans, Too!

The same engineering talents and the same careful construction go into the many stack supporting draft fans we have designed for the so-called "packaged" boilers. In some ways, engineering faces more difficult design problems because of the utmost efficiency required in a relatively small space.

Green Stack Supporting Draft Fans are practical, too. They are readily accessible for inspection and maintenance. Shafts and wheels are removable endwise without disturbing the stack or other structural members.

To those manufacturing "packaged boilers" or to those operating them with fans that don't seem to be doing the proper kind of a job or where maintenance seems too high, we offer the services of our experienced fan engineers to (1) design fans suitable for the boiler or (2) study the problem and recommend the remedy.

Our New Bulletin 168 gives details of our Stack Supporting Draft Fans. Write for a copy.

THE GREEN *Fuel Economizer* COMPANY INC.

BEACON 3, NEW YORK

ECONOMIZERS • FANS • AIR HEATERS • CINDERTRAPS

ENGINEERING ECONOMICS

(Continued from page 57)

voltage transmission distance and the size of line conductors.

For a definite kva capacity the yearly expenses will decrease with a decrease in line voltage; also, for a definite line voltage the yearly expense will increase with an increase in the kva capacity, and *vice-versa*.

For an increase in the generating cost of energy with a definite transmission distance, span length and delivered load, there will result an increase in the size of conductors and line voltage, but a decrease in the transmission costs per kva or kw-year—assuming, throughout this summary, the most economical transmission.

For an increase in the distance of transmission with a definite generating cost of energy, span length and delivered load, there will result an increase in the line voltage, the transmission cost of energy, and the sectional area of the conductors.

For an increase in the delivered load with a definite generating cost of energy, span length and transmission distance, there will result an increase in the line voltage and size of line conductors, but a decrease in the transmission cost of energy per kw or kva-year.

A *long distance* transmission will require a high voltage to satisfy the most economical conditions.

So long as power transmission lines exceed certain limits, the capacity current I$_c$ will present a difficulty, and may be the most dominating influence.

If the kva capacity and distances are increased greatly, the magnitude of line disturbances will increase, and the effect of line reactance may place a limit on the most economical transmission distance.

For a fixed power output the yearly charges per kw on the line conductors will increase with the square of the transmission distance, but the charges on the line supports will increase directly with the distance (assuming constant transmission voltage and constant ohmic voltage drop or constant percentage power loss).

For the transmission of a given amount of energy over a given distance, the first cost of line conductors can be reduced only by increasing the transmission voltage.

The limiting distance to which electric power can be transmitted economically, and with the required safety and reliability, depends very largely upon the gross cost of the line conductors and their supports plus ample insulation.

The yearly capital charges on the complete transmission line *plus*

No Other Water Conditioning System Has All of These Features...

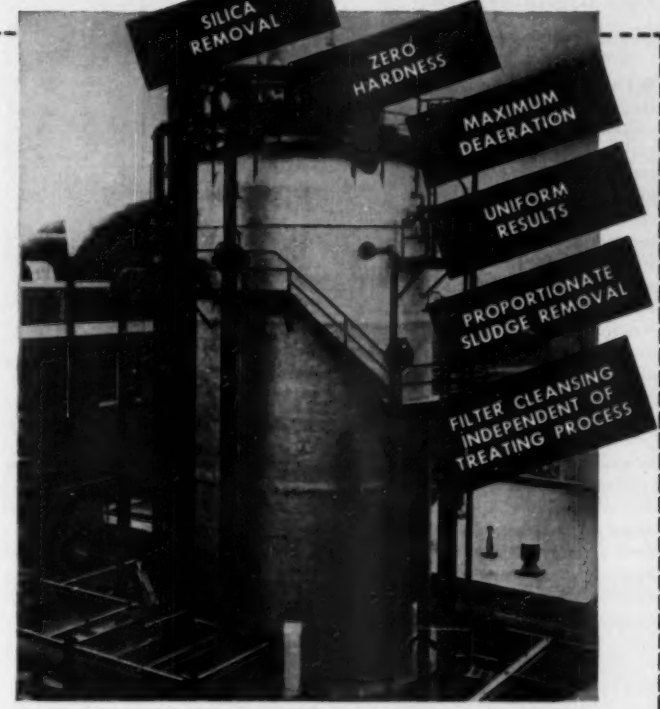
...ALL IN ONE TANK:

YES, you get all these and more, too, in one tank without the aid of internal mechanical agitation or other moving parts when a water conditioner like this 900,000 lb. per hour Worthington installation treats your make-up or condensate water.

In less space you get all the heating, chemical feeding and clarification facilities to provide optimum water conditioning results. Worthington's engineering skill and complete manufacturing facilities offer you the advantages which can only result from carefully coordinated effort under one responsibility.

WRITE FOR FACTS

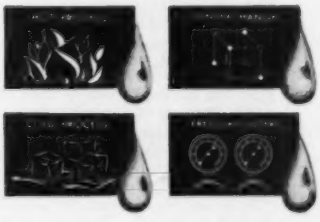
For proof that, in water conditioning as in so many other services, *there's more worth in Worthington*, write for Bulletin W-212-B2. *Worthington Pump and Machinery Corporation, Water Treating Division, Harrison, N.J.*



Main treating tank of a Worthington Hot Process Water Conditioning System, capacity 900,000 lb. of treated water per hour

Six pressure filters 11 feet in diameter used for final clarification in this Worthington Hot Process Water Conditioning System

58-3



WORTHINGTON

WATER CONDITIONING

Worthington Makes More of the Equipment For All Types of Water Conditioning Systems

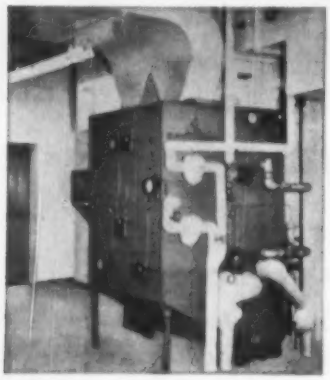
New Method Gives Precise Control in Air Conditioning

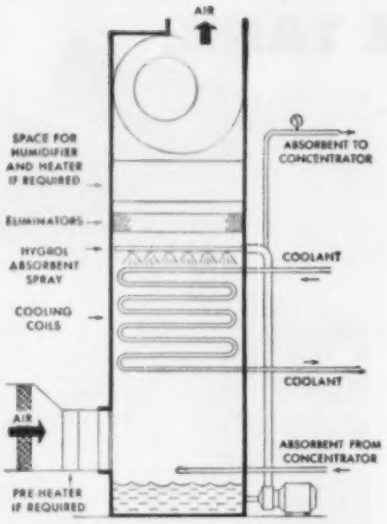
Niagara "Controlled Humidity Method" Uses Hygrol, Hygienic Liquid Absorbent

● The Niagara "Controlled Humidity Method" is a new system of air conditioning giving complete control of temperature and relative humidity, holding constant conditions or varying them at the will of the user. Especially, it provides dry air at normal atmospheric temperatures with little or no refrigeration required. A condition of 15 grains of moisture per pound of air at 85 deg. F. dry bulb temperature has been produced without refrigeration.

The apparatus is enclosed in a casing thru which the air is drawn by fans. The air is filtered and then enters a chamber where it is dehumidified in passing thru a spray of "Hygrol" Liquid (a hygienic hygroscopic chemical that absorbs the air-borne moisture and contains no salts or solids to precipitate) In the same chamber are located cooling coils which remove the latent heat of evaporation and also sensible heat as required.

The absorbent liquid spray falls into a tank at the base, where it is piped to a concentrator, removing moisture taken from the air. The re-concentrated liquid returns to the system. This process is continuous, and the apparatus operates at full capacity at all times.





NIAGARA CONTROLLED HUMIDITY METHOD — FLOW DIAGRAM

The same equipment may be used to provide winter air conditioning when required, by installing a tempering coil at the outdoor intake, an humidifier, and a reheat coil above the eliminators.

This equipment is manufactured in a range of sizes providing from 1000 to 20,000 CFM of conditioned air from a single unit, and mutiple unit installations are practical. It is expected that, by reducing the need for refrigeration, the cost of air conditioning will be reduced by this method. Applications generally are in a temperature range from 35 deg. F. upward. Below the freezing temperature of water, the Niagara "No-Frost" method is applicable.

The equipment is protected by U. S. and foreign patents. Installations have been made in food and chemical process industries, in packaging hygroscopic products, for preventing condensation of moisture on metals and other products in storage, in air conditioning for laboratory control and for human comfort.

For further information, write Niagara Blower Company, Dept. E, 405 Lexington Ave., New York 17, N. Y.

the minimum profit considered satisfactory, are of first importance in determining the distance to which power can be transmitted economically and uninterruptedly —the less this sum, the greater the distance to which power can be transmitted.

CENTRIFUGAL BOILER FEED PUMPS

(Continued from page 63)

capacity curve will be continuously rising to shut-off and permit satisfactory parallel operation.

Driver Horsepower

The process of selecting the proper size of the boiler feed pump drivers differs in no way from any other engineering thought process in that, fundamentally, it is strictly a matter of using common sense. A boiler feed pump is selected for a given capacity and a given pressure and it is expected that it will not operate at any capacity beyond the design condition. In other words, in direct contrast to a standard water pump where the power consumption might increase with a decrease in head and, consequently, an increase in capacity, a centrifugal boiler feed pump has a very definite maximum capacity. This is because a boiler feed pump operates on a system head curve made up of the boiler pressure plus the friction losses in the line.

If the boiler feed pump design capacity is chosen as the maximum capacity that can be expected under emergency conditions, there cannot be an increase in capacity because any pressure requirement corresponding to an increased capacity would be greater than the design pressure of the pump. See Fig. 6.

This must be qualified to the extent that the design pressure may be greater than actually required because of the addition of a safety margin. Even then, the boiler demand would probably never exceed the design capacity and the feedwater regulator would impart additional artificial friction losses to increase the required pressure up to the pressure available at the pump, as shown in Fig. 7.

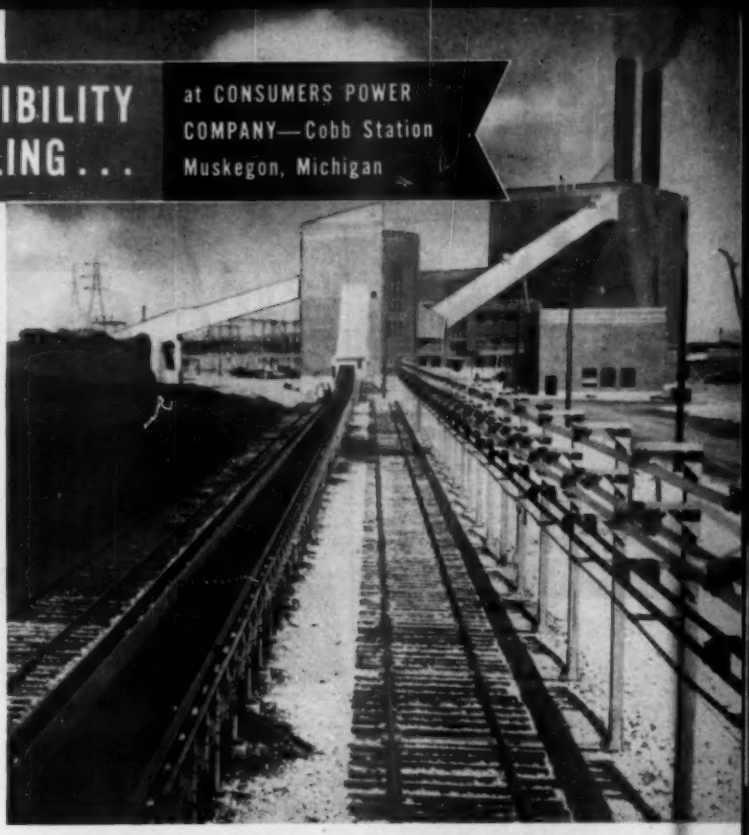
The same analysis holds true if two or more pumps are operated in parallel, feeding into a single boiler. Should one of the pumps be taken off the line at part loads, the remaining pumps could easily operate at capacities in excess of their design, since the system friction curve would intersect their performance curve at a pressure lower than the design pressure. See Fig. 8.

All that is necessary in such a case is to determine the pump capacity at the intersection point and the horsepower corresponding to this capacity.

It is hardly necessary to select a

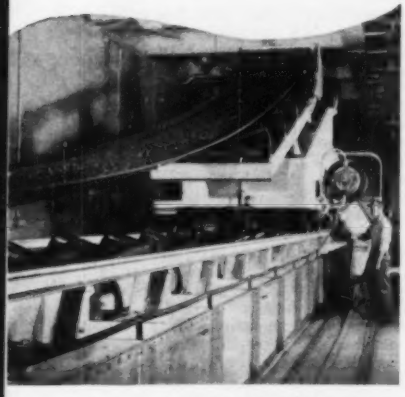
CONVENIENT FLEXIBILITY in COAL HANDLING . . .

at CONSUMERS POWER COMPANY—Cobb Station
Muskegon, Michigan



View of the yard conveyor carrying coal to the feeder conveyor in the breaker house, thence to the coal bunkers.

The Link-Belt motor-driven, traveling tripper with stack conveyor removes all or any part of the coal from the 1230-foot-long yard conveyor.



A close-up of the 42" wide belt conveyor and the Link-Belt motor-operated, traveling tripper distributing the coal to the bunkers. Note the plow on the discharge chute which opens and closes the bin seals for maximum dust confinement.

LINK-BELT COAL-HANDLING SYSTEM INCORPORATES SELECTIVE HANDLING, STORAGE AND RECLAIMING

At this new, modern generating station the coal is brought to the dock in bulk freighters and in self-unloading boats. From the bulk freighters the coal is carried by crane to a feeder belt conveyor, thence to a transfer belt conveyor. The self-unloading boats discharge through a hopper to the transfer conveyor.

This transfer conveyor, with two speeds, carries 1200 or 1800 tons an hour to the open-belt yard conveyor which is 1230 feet long and has a choice of three speeds, two for unloading the boats, and one for reclaiming coal from storage. For storing coal, a motor-driven traveling stacker removes the coal from the yard conveyor. In reclaiming, a crane loads the yard conveyor. By varying the speed of the feeder from the reclaiming crane, coal from the boats and storage can be mixed in any desired proportion.

The yard conveyor also discharges through a chute on to a feeder in the breaker house. From this feeder the coal passes through a magnetic separator and either through or by the breaker to the plant conveyor where a Link-Belt traveling tripper distributes it to the bunkers.

A reclaiming hopper, feeder, and conveyor to the breaker house is available for reclaiming coal from storage in case of failure of the reclaiming crane.

This is a good example of Link-Belt engineering in modern coal handling. Link-Belt equipment and "know how" may be the way out of your coal-handling difficulties—whether in a public utility or industrial power plant. A modern system engineered to meet specific conditions does cut handling costs. Why not ask our nearest office for more particulars.

LINK-BELT COMPANY

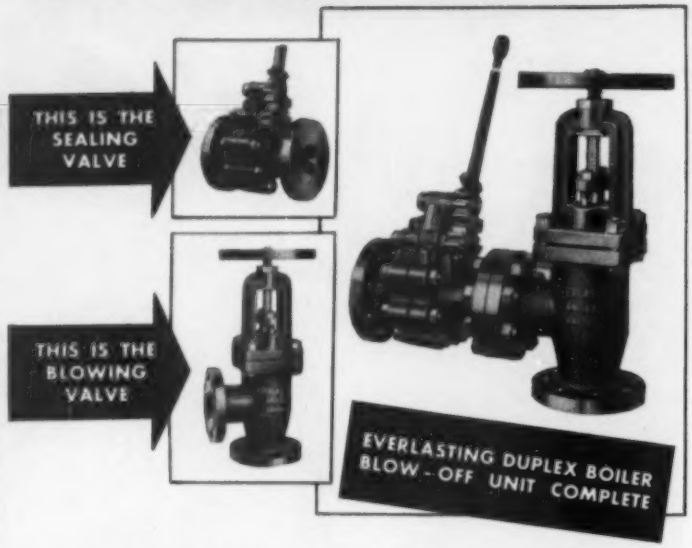
Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 3, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

12.6/4

LINK-BELT

COAL and ASHES HANDLING EQUIPMENT

CO-ORDINATED FOR BLOW-OFF SAFETY



A "regular" *EVERLASTING* Valve that opens fully with one short movement of the lever . . . a wheel-operated *EVERLASTING* Companion Valve built to take the full punishment of the blow-off . . . these two valves, coupled together, provide a combination that meets full code requirements for dual-valve blow-off.

The lever-operated *EVERLASTING* Valve, designed for unimpeded, straight-through flow, maintains its tight seal, because it re-grinds itself with each operation. It cannot wedge or stick.

The *EVERLASTING* Companion Angle Valve, designed specifically for blow-off service, stoutly resists erosive blow-off water and the abrasive action of solids in such water.

Either valve obtainable separately if desired.

For full information write us for *EVERLASTING* Bulletin.

EVERLASTING VALVE CO., 49 FISK STREET, JERSEY CITY 5, N. J.

Everlasting Valves

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EV 2744

for everlasting protection

driver of such size that it will not become overloaded at *any* point of the boiler feed pump operating curve. At the same time, while under average conditions electric motors used for boiler feed service have an overload capacity of 15 per cent, it is generally the practice to reserve this overload capacity as a safety margin and to select a motor which will not be overloaded at the design capacity. For instance, if the brake horsepower at the design capacity is 205 hp, a 250-hp motor should be used, while if the power at the design capacity is 95, a 100-hp motor is needed.

Turbine Drives

With turbine-driven pumps, the problem is somewhat different for two reasons:

1) Turbines are not built in definite standard sizes, but can be designed for any intermediate odd power rating as requested.

2) Turbines cannot be overloaded and burnt out. If the power demand on a turbine exceeds its rating, the turbine will simply slow down until the power demand and the available power are again equalized.

Theoretically, therefore, if the brhp at the design capacity was 95, a 95-hp turbine could be selected to drive the boiler feed pump. Likewise, if the brhp was 205, a 205-hp turbine could be used. However, it must be considered that turbines do not necessarily have the overload margin available in electric motors and it is recommended that some leeway, in the order of 5 per cent be allowed in the selection of the turbine horsepower.

Excess Capacity

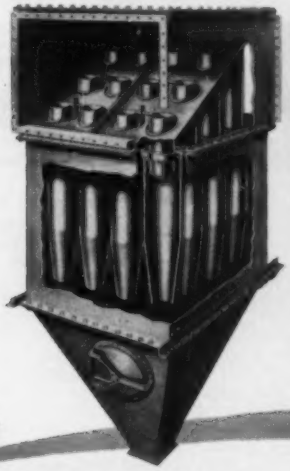
Frequently, when the choice lies between two consecutive motor horsepower ratings, the actual difference in dollars and cents is really negligible. At the same time, the provision of a liberal margin between pump brake horsepower and motor size has very definite advantages. For instance, if it should ever become desirable, because of an unforeseen expansion, to increase the boiler feed pump rating through the use of new impellers, the driving motor would not need to be replaced. Provision of extra power in a turbine for similar reasons is not always necessary, as a turbine can generally be renozzled, for a considerable increase in power, at a nominal cost.

* * *

Amazingly tiny screws are being mass produced by a nationally known watch company. These screws, which are considerably smaller than the diameter of a small needle, are completely threaded and slotted. They are used in adjusting the balance wheels of watches and in military timing instruments. One million screws weigh approximately one pound!

—Ohmite News

Before you buy *any* equipment for recovering dust or fly ash . . .



COMPARE ALL OTHERS against MULTICLONE'S Multiple Advantages

Because the advantages of MULTICLONE are so clear-cut, so vitally important, so far-reaching in the savings they make, we urge you to make a factual unbiased comparison of MULTICLONE dust and fly ash collection equipment against *any other* in the mechanical recovery field. Only by making such a comparison can you fully appreciate the major savings and greater performance you get by installing MULTICLONE Collectors!

COMPARE Recovery Efficiency!

It is a recognized fact that the separating efficiency of a cyclonic tube increases as the tube diameter decreases because smaller tubes generate greater centrifugal forces. The patented vane in the MULTICLONE makes the use of small tubes *practical* without complicated manifolding and permits compacting many small tubes into one simple, highly efficient unit. MULTICLONE's higher centrifugal forces throw out not only the large, medium and small particles, but also an unusually high percentage of the *extremely small* particles of 10 microns and less. Result—*more complete recovery of all suspended particles from the gas stream!*

COMPARE Space-Saving Compactness!

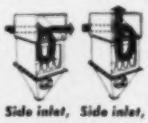
Plant space costs money—particularly at today's high construction costs. Because the MULTICLONE is more compact, size for size, it makes *really important* savings in space and plant costs. Note in the chart how the MULTICLONE requires substantially less space—*both in floor space and cubic space*—than any other unit of comparable capacity and performance. *This means vital savings in construction costs!*

Make	Relative Space Requirements In Sq. Ft.	In Cu. Ft.
Multiclone	1.0	1.0
Collector A	2.1	1.8
Collector B	5.9	3.2
Collector C	6.8	3.9

COMPARE Dollar-Saving Adaptability!

Savings in space is just one of many ways MULTICLONE reduces installation costs. Because the shape of the unit can be readily varied (long and narrow, short and wide, or square) to fit available spaces, the MULTICLONE can often be tucked into odd corners and waste areas too restricted for other equipment.

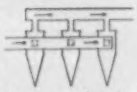
Moreover, inlet-outlet ducts can be varied—side-inlet side-outlet, or side-inlet top-outlet—to meet low headroom or restricted side clearance requirements . . . and the single-inlet single-outlet duct design permits greater flexibility and simpler installation. *These all add up to vital savings in installation costs!*



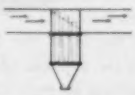
Side inlet, Side outlet *Side inlet, Top outlet*

COMPARE All-Around Simplicity!

The MULTICLONE is simple and inexpensive to maintain because there are no high-speed moving parts to repair or replace . . . no pads or filters to clean or renew . . . nothing to choke the gas flow or increase draft losses as suspended materials are recovered. In addition, the square, flat-sided shape of the MULTICLONE and its straight inlet and outlet ducts are far simpler to install and insulate. And since the recovered material from an entire bank of tubes is collected in a *single* hopper, it is much easier to service and maintain than the multiple hoppers of conventional cyclone units. *Here again, the* MULTICLONE *saves in many ways—all of them important!*



Conventional Cyclone



Multiclone

Whether your recovery installation is in a new structure or for modernizing present equipment, you will be far ahead by installing MULTICLONE Collectors. Our experienced engineers will gladly make helpful suggestions for simplifying your recovery problems. A letter, wire or call to our nearest office places this assistance at your service without obligation.

Send for Helpful Literature! This factual MULTICLONE literature explains the basic principles of cyclonic dust recovery and gives technical data helpful to anyone contemplating a dust or fly ash recovery installation. Write today for your free copy!

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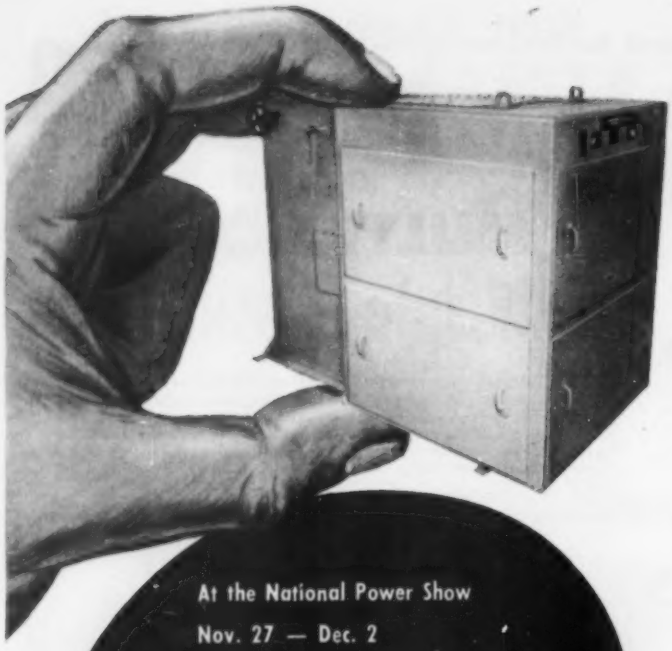

At the National Power Show
Nov. 27 — Dec. 2

take a good look

at Richardson's *Pressure-tight*
"K-39" Automatic Coal Scale

You'll see it at the Power Show—Richardson's "K-39" Automatic Coal Scale, capable of standing pressure up to 60 inches of water and maintaining its weighing accuracy.

Yes, it stays tight . . . won't allow primary air to leak into boiler room. It stays "right" too, checking coal consumption to within ounces by the hour, shift or week. Inefficient steaming can be spotted immediately and corrected quickly. Result: *major savings* for stoker-fired or pulverized-fired central stations and power plants.

Learn how to get full efficiency from every boiler or turbine in your plant—write for Bulletin No. 0250. Or have a Richardson engineer discuss your fuel consumption problems with you. There is no obligation.

Richardson
MATERIALS HANDLING BY WEIGHT SINCE 1902

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CAPACITOR APPLICATION FOR LOAD RELIEF

(Continued from page 80)

$30, kva has dropped in an amount less than 1. It would have been a better buy to install one kva of transformer for $30!

Try another 3.57 kvar of capacitors. See Fig. 10. Again, only 0.9 (or less) drop in kva for the expenditure of $30. Clearly, we have passed the economic limit.

KVAR from Synchronous Motors

Leading kvar are generated by PF synchronous motors. The investment cost per kvar can often be reckoned as the difference in costs of the complete-with-exciter-and-control synchronous motor and the equivalent complete-with-control induction motor, divided by the sum of the leading kvar generated by the synchronous motor and the lagging kvar required by the induction motor. There are many other considerations such as relative efficiencies, control complexity, space, and maintenance, but we are here considering only the investment costs.

Using the nomogram, the distribution engineer can sometimes justify at least a minimum capacitor installation on an investment costs basis alone. Improved voltage regulation and reduced line losses then become "free" benefits.

CATALOG LIBRARY

(Continued from page 48)

236 **Combustion Catalysts**—Bulletin 36. 4 pp, explains the action of company's combustion catalysts, including one type developed for use in coal-fired furnaces and another for use in oil-fired furnaces. Tells how they help to remove soot, control smoke and alleviate the slagging problem in boiler furnaces. Also describes a simple hopper-type feeding device available for spraying the catalyst into coal-fired furnaces. National Aluminate Corp.

237 **Heating Unit**—This bulletin presents advantages of company's gas- or oil-fired self-contained industrial heating unit, explaining its operation, simplicity of installation, and describing and illustrating some of its applications. Includes specifications. Also contains engineering data to help analyze industrial heating problems, including procedures to determine heat load, fuel consumption. Thermobloc Div., Prat-Daniel Corp.

238 **Fan Heater Bulletin**—Here's a 2-pp illustrated bulletin (No. 100) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. One page is devoted to description and photos of the heater. Other page contains a sketch in color showing how the heater works. Niagara Blower Co.

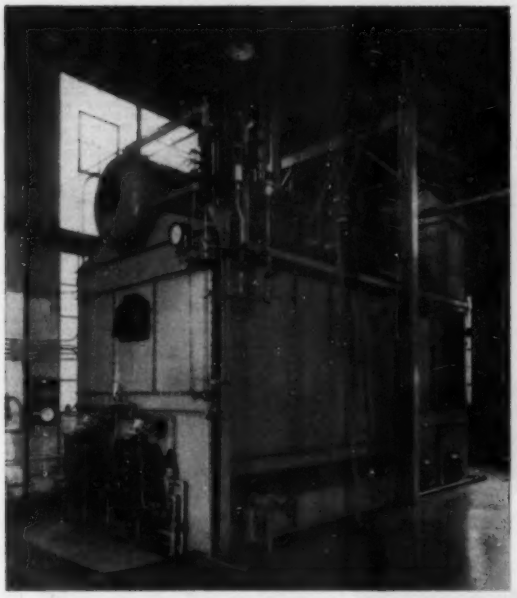
WATER TREATING, CORROSION PREVENTION

239 **Water Conditioning Bulletin**—This is an 8-pp discussion of water and the chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also discusses special purpose chemicals. Wright Chemical Corp.

240 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-pp

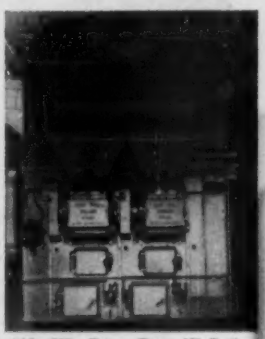
A LOW HEADROOM BOILER

That can take it

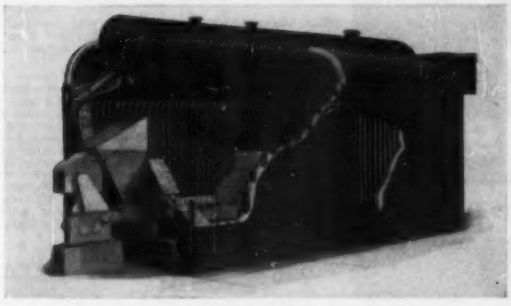


250 HP Erie City VL-Boiler oil fired at a western New York dry cleaning plant.

THIS compact, low headroom 2 drum water tube boiler features extra large water and steam capacity. Side wall water cooling reduces refractory maintenance to the vanishing point even at maximum ratings. As illustrated here the VL is well adapted to all firing methods. The VL's all steel casing and trim appearance makes any boiler room a showroom. It is recommended for sizes to 750 HP and is furnished as a completely shop assembled unit in sizes to 300 HP and larger depending upon railroad clearances.



160 HP Erie City VL-Boiler fired by Erie City Spreader Stoker in an Ohio automobile manufacturing plant.



Outstanding of many VL features is the ring-flow circulation in each side wall element. A downcomer tube for each pair of radiant (riser) tubes in the side wall with auxiliary front wall downcomers assure an ample supply of clean circulating water in the walls at all times. Tile between riser and downcomer tubes assures rapid and unrestricted circulation.

200 HP Erie City VL-Boiler fired by Erie City Underfeed Stoker in a western paper products plant.

FOR COMPLETE DATA
***write for* BULLETIN SB24B**

COMPLETE STEAM POWER PLANT EQUIPMENT

ERIE CITY

Complete Steam Generators • Type C 3-Drum Boilers • Types VL & VC 2-Drum Boilers • "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • "Keystone" Packaged Steam Generators • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

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No need to jam a Dart to get it tight. The true ball joint—with precision-ground bronze-to-bronze seats — always gives a snug fit without excessive wrenching. An important reason why Darts always tighten so easily—then uncouple easily for repeated use. And, in service or storage, the practically indestructible air refined malleable iron body and nut keep the seats safe from damage.

For true economy, you'll find it pays to buy this better union by Dart.

E. M. DART MFG. CO.
Providence 8, Rhode Island

DART
UNIONS

technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater system. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. %Proportioneers, Inc.%.

241 **Water Softener Equipment**—How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Contains a 2-pp cutaway illustration of a fully automatic softener to show how an ion exchanger is built and how it works. Bulletin also contains flow diagrams showing arrangements for installation of water softeners. The Permutit Co.

242 **Anti-Foam Treatment** — This 4-pp bulletin covers a new formula in powder form to be applied along with anti-scale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the problem of steam contamination and explains the action of this polyamide anti-foam treatment. Tells how it should be applied and gives dosage requirements. A discussion of its advantages is accompanied by photos showing the effect of polyamide action on a boiling dilute Nacconol solution. Dearborn Chemical Co.

243 **Boiler Corrosion** — A 12-pp article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its Effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. Numerous illustrations, graphs and tables included. W. H. & L. D. Betz.

244 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin 2B37030. Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurrence data on compounds found, composition of turbine deposits from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. Allis-Chalmers Mfg. Co.

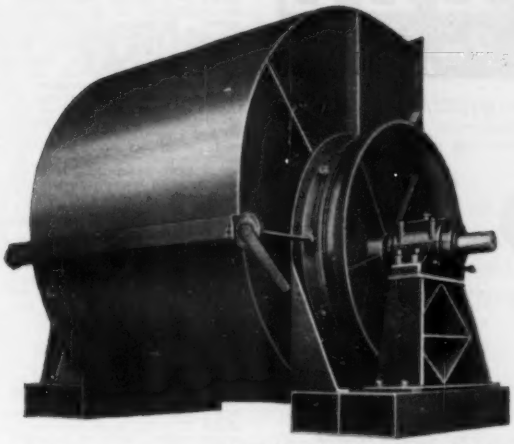
245 **Two-Stage Water Conditioner**—Bulletin 4801 describes company's water conditioner which combines the advantages of both hot process and zeolite softening. Explains operation of softener in which the first stage is the hot process using lime or Dolomitic lime and the second stage in which zeolite softener reduces hardness to zero. Discusses advantages of the combination—silica reduction, low alkalinities, lower CO_2 in steam, lower costs and tells applications to high pressure boiler plants. Cochrane Corp.

246 **Corrosion Treatment**—"Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Booklet gives specific case histories and typical economies obtained by power plants using this treatment. Includes graphs showing relationship between free CO_2, pH and alkalinity in water, and the solubility of oxygen in water when exposed to air at various pressures. The Bird-Archer Co.

247 **Chemical Feed Systems**—Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of 4-pp Bulletin 4811. It discusses in detail sodium sulfite feeding, internal treatment, chemical feeding, manual control, intermittent feeding of internal treating chemicals; automatic feed systems; automatic pH control, and automatic control by conductivity. Illustrations include photos and diagrams of controlled volume pumps. Milton Roy Co.

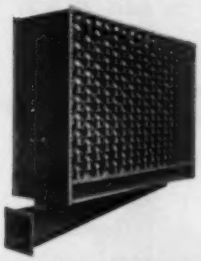
248 **Modern pH and Chlorine Control**—This 100-pp booklet is much more than a catalog, although it does give full technical details of all the color comparators and equipment in water testing and

Worth looking into (we say)...
AMERICAN BLOWER HS FORCED DRAFT FANS

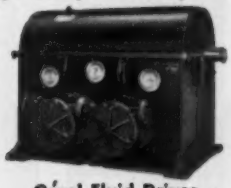


American HS Forced Draft Fan

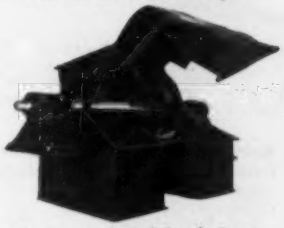
Heavy Duty Coils



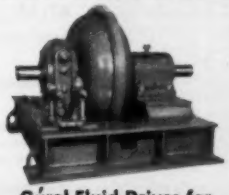
Type ST Fly Ash Precipitators



Gýrol Fluid Drives for Boiler Feed Pumps



Sirocco Induced Draft Fans



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Over the years, refinements in design and proportions have materially increased static efficiencies. The streamline inlet overlapping wheel rim prevents entry loss and turbulence and aids in obtaining high efficiency. Housings are of heavy welded steel up to $\frac{3}{8}$" in thickness, with flanged outlet connections, and are reinforced for maximum rigidity.

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And, if you'd like complete data on other American Blower Mechanical Draft Equipment as well as on Fly Ash Precipitators, Heavy Duty Coils and Gýrol Fluid Drives for fan control and boiler feed pumps—merely write, stating your requirements, or phone our nearest branch office.

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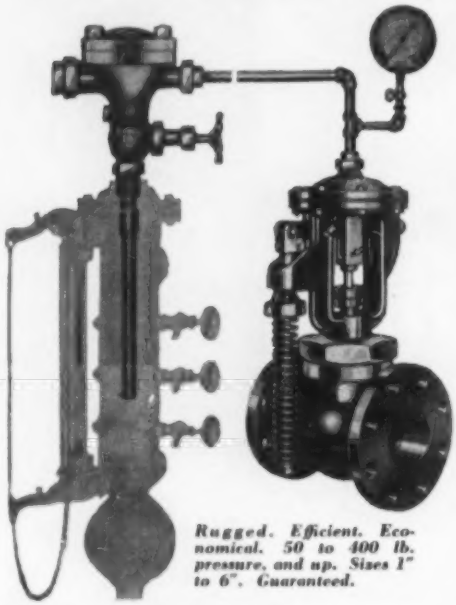

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control of boiler and industrial process water manufactured by this company. Its most important feature is inclusion of technical information on the meaning of pH control, electrometric and colorimetric methods of determining pH and also determining constituent impurities in water; applications of water control in air conditioning; treatment of boiler feed water and industrial water, and other industrial applications. Color comparators are detailed and illustrated. W. A. Taylor & Co.

249 **Water Softeners**—Bulletins WC-102 is a 36-pp presentation of recent developments in hot-process water softeners. Explains boiler plant troubles caused by various impurities in water, outlines 12 methods of treating water to eliminate these impurities, describes reasons for the popularity of the hot-process method and its advantages, and explains the chemistry of hot-process water softening. The two basic designs and operation of company's hot process softeners are described, together with six adaptations of each design to various plant conditions, such as per cent make-up, treatment of condensate, deaeration. Methods of supplementary hot phosphate treatment are also discussed. Includes diagrams of hot process designs and flow charts, photos of installations. Graver Water Conditioning Co.

250 **One-Minute Water Tests**—Rapid, simple and accurate tests for determining water hardness are described in Bulletin 1RE50, 4 pp. Procedures, reagents, and equipment for the new tests are pictured and described. The test procedure is said to take 1 min to complete and because of clear-cut color change at endpoint to afford increased accuracy. Bulletin tells how tests may be used to determine total water hardness, hardness due to calcium alone and hardness due to magnesium alone. Hall Laboratories, Inc.

251 **Boiler Water Treatment**—Bulletin 47, 8 pp, is on internal treatment of boiler water. Defines internal treatment and tells its advantages in softening, sludge conditioning, stabilization. Explains operation of company's system, including the chemicals used, feeding and testing equipment. National Aluminate Corp.

252 **Water Hardness Test**—This technical bulletin presents a test procedure for determining hardness of water, by use of a color indicator which is described as both easy and accurate. Instructions for running the test are illustrated in color. Includes prices of company's complete hardness titration set and individual solutions used. W. H. & L. D. Betz.

253 **Ion Exchange Systems**—"Amberlite Monobed Deonization" is a 12-pp miniature textbook covering the history, behavior, present performance, and potential uses of the Monobed ion exchange systems in water-conditioning, chemical processing and other industries. Reactions of various combinations of exchangers are explained in text and equations. Also discussed are operating costs, equipment costs, quality of product derived, rinse requirements and other properties as they apply to the complete or partial single-step removal of ionized solids from solution. Design and operation of Monobed equipment is described and more than 80 fields of application listed. A table gives nomenclature, chemical behavior and typical uses of six different systems. The Resinous Products Div., Rohm & Haas Co.

PUMPS, COMPRESSORS, ENGINES

254 **Centrifugal, Reciprocating Pumps**—This is a helpful collection of bulletins covering many types of centrifugal and reciprocating pumps for a wide range of services. Includes data on single-stage and multi-stage pumps, close-coupled pumps, high pressure pumps, pumps especially suited for handling erosive and corrosive liquids and others. Contains photos, dimensions, specifications, ratings and application information. Warren Steam Pump Co., Inc.

255 **For Many Pumping Jobs**—The Series A313A, latest of company's well-known IMO pumps and especially designed for low cost standardized, quantity production, is described in illustrated Bulletin L313A-B, 8 pp. This is a general service screw-type rotary pump for petroleum products and other light or viscous fluids as required for rotary and steam atomizing oil burners, oil transfer, lubrication, hydraulic systems and similar services. Bulletins contain a cross-section drawing, description of the IMO pumping principle, viscosity tables and motor frame sizes. De Laval Steam Turbine Co.

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Costly plug cleaning, with its high labor bills and lengthy equipment down-time, goes out of the condenser and heat exchange picture the minute chlorination arrives.

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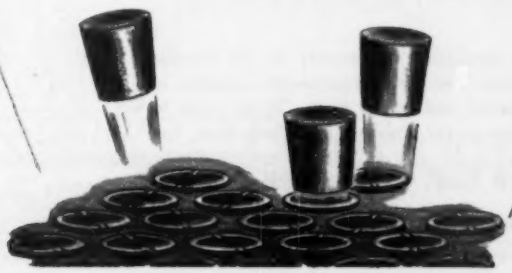

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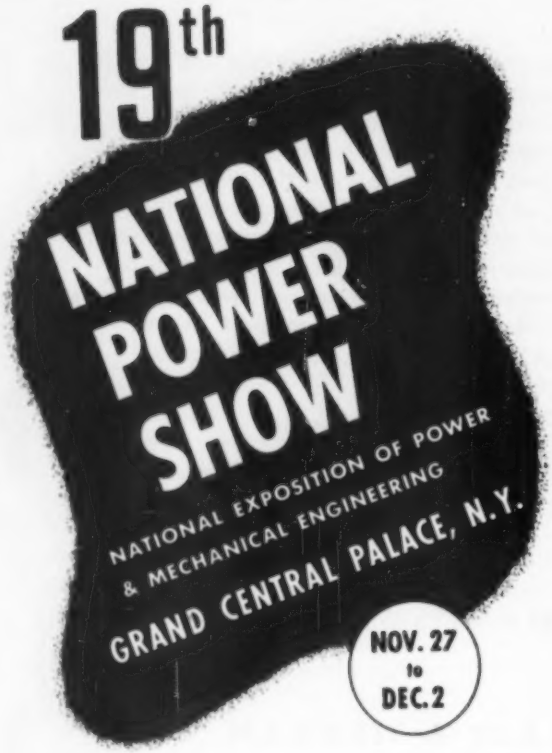

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256 Compressor Selection Chart—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

257 Air Compressor Lubrication Manual—Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated. Cities Service Oil Co. (In the South, Akansas Fuel Oil Co.)

258 Modern Steam Engines—In presenting steam engines as more than "just drives," Bulletin 306 touches briefly upon some of the advantages of "by-product" power. Bulletin features company's vertical steam engines of both throttling and automatic governor types. Sectional drawings are accompanied by engineering data, an illustrated discussion of construction features and photos of installations. Troy Engine & Machine Co.

259 Pump Packings—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes a table of recommendations to facilitate selecting the right packing for any particular application. Johns-Manville.

TURBINES

260 Turbine Catalog Collection—This is a valuable collection of bulletins in loose-leaf form. They cover a complete description of manufacturer's solid wheel turbines and feature cross section drawings of typical units for both moderate and high steam pressure conditions. Also provides a description of an axial flow impulse, both single and multi-stage, and complete data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

261 Velocity Stage Turbines—Catalog 82-19R, 8 pp, features turbines for mechanical drives designed to operate under all inlet steam conditions up to 600 psig and 750 F. Gives complete specifications, dimensions and includes chart showing how to estimate turbine sizes. Illustrations include cutaway view, photos of parts. Speed governor and regulating valve, and emergency governor and trip valve are described. De Laval Steam Turbine Co.

FUELS, LUBRICANTS

262 Steam Power Plant Auxiliaries—In Vol. 36, No. 4, of Lubrication, a technical publication on selection and use of lubricants, is an article on recommended lubrication practices for steam power plant auxiliaries. Illustrated with photos and sketches, it discusses automatic coal firing machinery, stoker design, pulverizers, tube cleaners, compressors, motors, fans and blowers, external reciprocating elements of pumps and compressors. The Texas Co.

263 Diesels, Their Fuels and Lubricants—This 46-pp book offers a well organized and attractive presentation of practical information on diesel engines, covering their history and economics as well as discussing their design characteristics and operating principles. Classification of diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, lubricating systems, and diesel oil purification and filtration. The balance of the book is devoted to a discussion of fuel and lubricating oil required by diesels and description of company's products. Book is filled with photos, sectional illustrations and schematic drawings; includes table showing relation of engine performance to fuel properties. Sinclair Refining Co.

264 Fuel Oil Treatment—By text and sketches, this folder points out undesirable conditions in the storing, pumping, heating and burning of industrial fuel oil and the correction of these conditions by company's fuel oil treatment. Defines sludge and includes instructions for ap-

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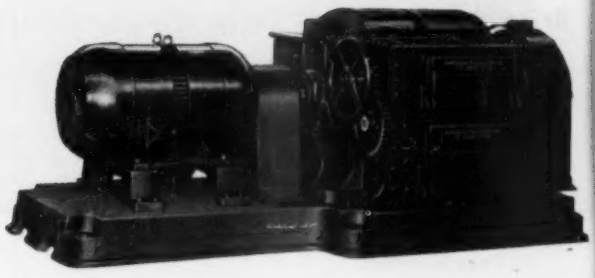

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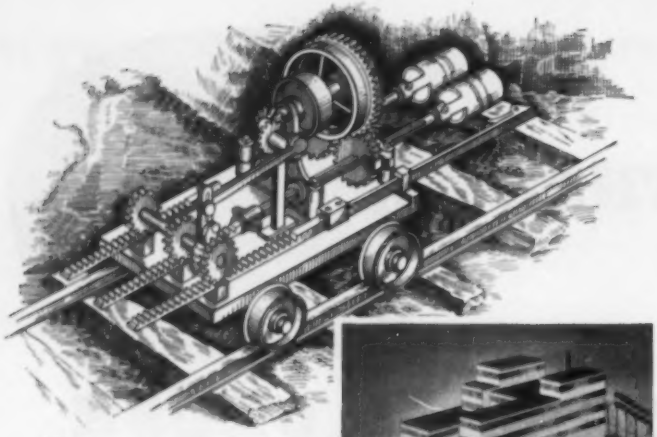

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Sinclair Coal Company, Kansas City 6, Mo.—Western Representative
Bean-Strachan Coal Company, Ltd., Montreal—Canadian Representative

plication of the fuel oil treatment. E. F. Drew & Co., Inc.

265 **The Answers on Turbine Oil**—This 2-pp booklet answers several questions power engineers ask about turbine oils, including: What causes deposits of sludge? What causes acidity increase? What causes corrosion in turbines? Explanations are brief but thorough. Booklet is illustrated with photos of turbine installations in which manufacturer's products have been used successfully. Standard Oil Co. (Indiana).

266 **Coal Scale Manual**—Recently-published Bulletin 0150 describes automatic coal scale construction and operation, illustrating special design features which provide for high accuracy and long service. Included in this book are installation photos, working drawings for typical installations, as well as dimensional data. Richardson Scale Co.

267 **Spreader Stokers**—Catalog 80, 44 pp, describes a spreader stoker with forward moving grate that slowly and continuously discharges ash at the front. Explains the efficiency and economy of this stoker, illustrating grate's design and operation. Includes discussion of typical power plant installations of these stokers, covering more than 30 industrial, institutional, municipal and public utility installations through the country. These are illustrated by photos and blueprint drawings. Detroit Stoker Co.

268 **Coal Handling Equipment**—Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated with sketches and photos of actual installations, it covers concrete and tile silos, cylindrical steel tanks, and suspended steel bunkers with gravity discharge bucket elevators and pivoted bucket carriers. Gifford-Wood Co.

269 **Spreader Stoker**—Bulletin SB 31, 4 pp, explains and illustrates, by photos, the design and construction features of company's spreader stokers, stressing their advantages. Also contains photos of installations. Erie City Iron Works.

270 **Small Crushers**—"For Better Testing and Small Scale Reduction" is the title of this 6-pp bulletin describing in detail the many practical applications of company's small crushers, grinders, and shredders for reduction of coal, by-products, chemicals, clays and many other products. Typical installations are clearly diagrammed and explained. Special attention is devoted to construction features and functional advantages of the different mills as applied to various reduction jobs. American Pulverizer Co.

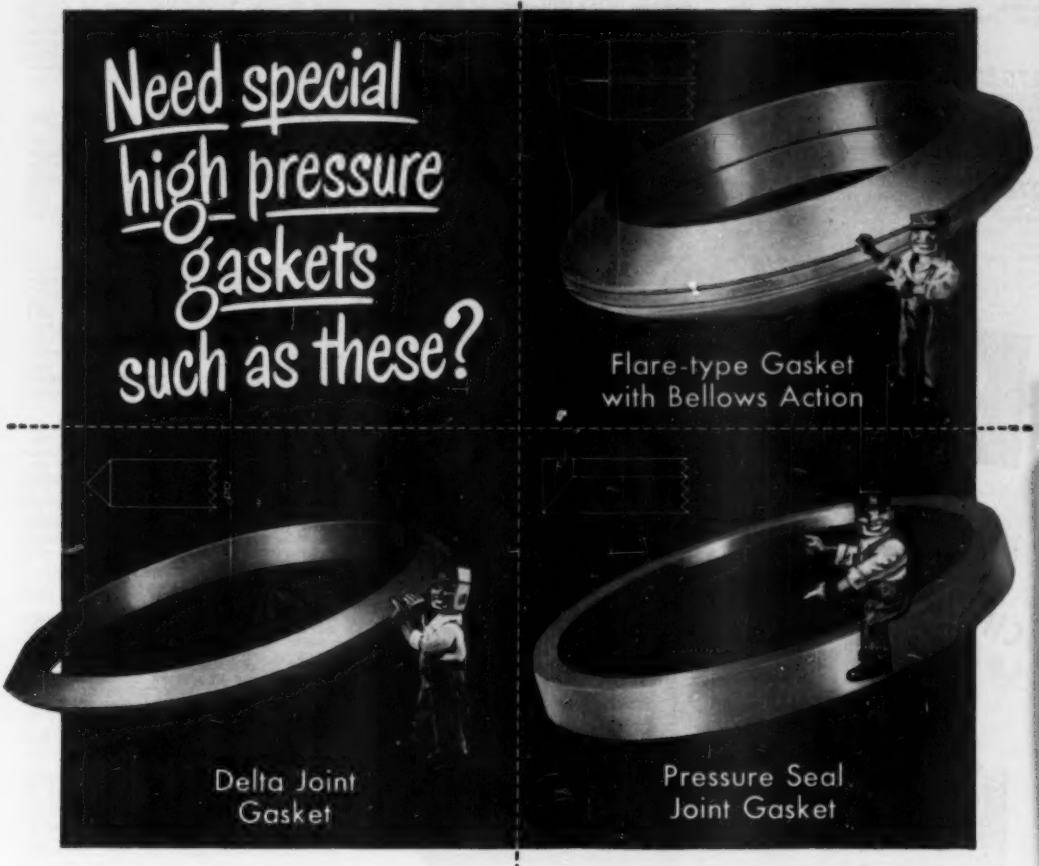
271 **Spreader Stoker Selection**—Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered in the selection. It pictures and describes in detail the principle operating parts of manufacturer's stokers, emphasizing their advantages. Includes engineering drawings and photos of typical installations. American Engineering Co.

272 **Spreader Stoker Data**—This is a file of three illustrated bulletins on company's spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operating features. The second is devoted to a discussion of the dumping grate mechanism and the third illustrates 15 typical installations. Riley Stoker Corp.

DUST COLLECTING

273 **Fly Ash Elimination**—Power engineers will find this 30-pp booklet outstanding among material on this subject. It presents manufacturer's "Multiclone" equipment (described as small-tube type of cyclonic dust collectors using centrifugal force for separating dust from gas stream) as a highly successful and economical means of separating fly ash—not as a panacea for all cinder and fly ash problems. Parts and assemblies are illustrated by photos and drawings and explained in terms of construction, operation and capacities. Particle size and its significance in fly ash elimination, is discussed and so is dust collecting efficiency as affected by operating conditions. Western Precipitation Corp.

274 **Dust Collecting Efficiency**—How the higher and narrower inlet utilized in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The gaskets shown above are typical of the wide variety for high pressure service that have been made to order for Goetze customers. The flare type gasket with bellows action illustrated at upper right is but one example of what Goetze "know-how" can accomplish.

Goetze has had over sixty years of experience in making specialized metallic gaskets for industry's most complex jobs. Modern machines—many of them specially designed and built by Goetze—enable Goetze craftsmen to produce gaskets of any required design, shape or size... and deliver them with remarkable promptness.

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company's tubular dust collector contributes to more efficient dust collecting is explained in this illustrated bulletin. Cutaway drawings showing tube design and micron efficiency curves accompany the text. Frat-Daniel Corp.

METALS

275 **Engineering Data on Inconel** — In addition to providing extensive information on Inconel, 34-pp Bulletin T-7 also presents details on the composition, mechanical properties and physical constants of Inconel X, one of the newer age-hardened Inco nickel alloys. The International Nickel Co., Inc.

276 **Steels for Hot Spots** — This is an 88-pp manual filled with information on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behaviour of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical property values of 21 steels; and illustrated description of major high temperature testing facilities in the United States, and a comprehensive bibliography of company's technical publications on the properties and use of steel at high temperatures. United States Steel.

MECHANICAL POWER TRANSMISSION

277 **Transmission Belting** — Catalog M-6922, 28 pp, gives detailed design, engineering and performance data on manufacturer's line of transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included in the manual, together with hints on proper selection of a belt and procedure for analyzing belt drives. Illustrations include many photos of belt installations and drawings of transmission drives. United States Rubber Co.

278 **Worm Gear Drive Manual**—Full engineering and ordering data on company's worm gear drives is presented in 88-pp Book 2324. Illustrated with photos and sketches it discusses types of drives and construction features and provides selection tips. Provides ratings, dimensions, overhung and thrust loads on several types of single, helical and double worm gear drives, and contains many photos of applications. Included with book is 8-pp current price list. Link-Belt Co.

279 **Hydraulic Couplings**—Bulletin 3924 is Vol. II of "Progress in Power." a 24-pp collection of company's advertisements covering the use of hydraulic couplings in power plants. They feature on-the-job interviews in public utility plants and depict the increased efficiency through the entire plant afforded by the use of fluid drives. American Blower Corp.

CONDENSERS

280 **Condensers** — Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Illustrated with photos and drawings showing complete assemblies, parts, principles of operation. Bulletin also discusses emergency replacements, service and maintenance facilities available, and auxiliary equipment. Includes condenser tube data, pressure-conversion tables. Condenser Service & Engineering Co.

281 **Steam Condensers with Reverse Flow**—Eight-pp Catalog 410-1 describes company's "self-cleaning" reverse-flow condenser for power plant service, designed to virtually eliminate cleaning down time and, in the case of divided water box condensers, eliminate necessity of operation at partial load. Explains and illustrates direction of water flow and reversing flow by tandem sluice gates, without sluice gates and in single pass condensers. C. H. Wheeler Mfg. Co.

OTHER EQUIPMENT

282 **Concrete Floors Q & A** — The detailed information contained in this booklet brings up to date, the service experiences and late developments in this field. The information covers methods and materials used in placing corrosion resistant concrete in a wide variety of industrial applications. Typical uses of corrosion resistant concrete are listed for many industries and also given, are the answers to questions often asked about it. Lumnite Division, Universal Atlas Cement Co.

283 **Corrosion Analysis**—Excellent working data on galvanic corrosion is contained in this 8-pp technical study of corrosion by concentration cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metal-ion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co., Inc.

284 **Wired Television**—Illustrated Bulletin 1025, 16 pp, introduces company's Utiliscope, a camera and monitor type of equipment designed to enable an observer to see where he can't look. Some of the many applications for this wired television which are described and illustrated include viewing instrument readings at remote points, checking boiler water levels, watching coal flow in chutes, watching hazardous laboratory tests, checking furnace ignition. Diamond Power Specialty Corp.

285 **Cleaning Industrial Equipment**—This is a general information bulletin on manufacturer's service for cleaning steam generating, heat exchange and other industrial equipment. Also included is information on pipe line cleaning and water well acidizing. Illustrations of these services are included, and bulletin treats in detail the methods used to remove incrustations from internal surfaces economically with minimum of downtime. Dowell Inc.

286 **Industrial Dry Coolers** — Illustrated Bulletin DC-50, 12 pp, presents company's line of dry cooling equipment for small, "in-between" and heavy-duty cooling jobs and includes three recently introduced models. Two of these are small "portable" units and the third a medium-size unit. Although designed primarily for cooling engine jacket water, they can also be used for cooling natural gas, lube oils, fluids of refining stages. Bulletin includes dimensions and weights, also rating tables for cooling water. The Marley Co., Inc.

For safety's sake choose Builders Visible Flow Chlorinizer. No other chlorine gas feeder offers better protection, quicker protection, more reliable protection against the escape of chlorine gas. Night and day, the powerful spring-loaded chlorine control valve keeps chlorine gas flowing under complete and exact control... yet it's ready at all times to shut off the flow automatically should *any* condition occur to interfere with *safe* operation of the Chlorinizer. This is another of the many worthwhile features you get only with Builders Chlorinizer. For engineering information and Bulletins, address Builders-Providence, Inc., 385 Harris Ave., Providence 1, R. I.

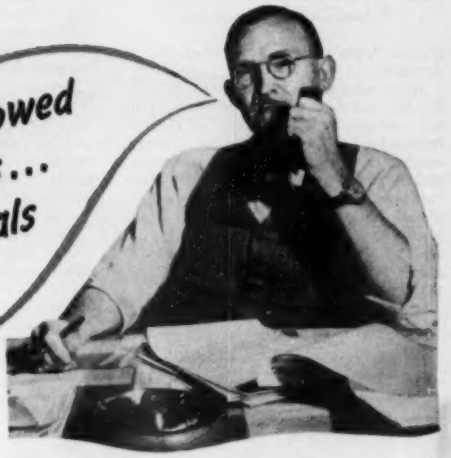
Builders makes a complete line of flow meters and controllers for liquids, steam, air, gas, and dry materials . . . mechanical and differential . . . including The Venturi Meter and Chlorinizers (chlorine gas feeders).

Installation at Simsbury, Conn.

BUILDERS PROVIDENCE
Instruments

Chief Research Engineer Reports on Valve Trim Materials

"S" Monel consistently showed better anti-galling properties... than any of the other metals we have tested...



Albert D. Eplett

These are the words of Albert D. Eplett, chief research engineer of MANNING, MAXWELL & MOORE, INC., Bridgeport, Conn.

As a result of controlled laboratory tests made under his direction over a period of years, "S" Monel* is now standard material for guide sections in four types of Consolidated Safety Valves.

Here Mr. Eplett tells you about one of the actual tests:

"We carried out our anti-galling tests," he says, "by building a small valve identical to the larger ones ordinarily used. We devised a cam-operated mechanism that would give us lifting characteristics similar to those that occur with steam. Superheated air was carried in through the nozzle and up over the disc and guide portions, where we located thermocouples. When galling occurred, a cut-out device shut off the operating mechanism.

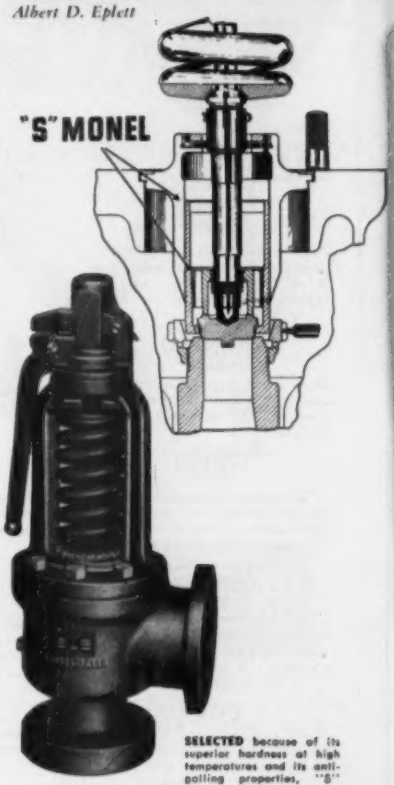
"By this method, we have tested a great number of valve trim materials, including the so-called super alloys. ***And we discovered that "S" Monel consistently showed better anti-galling properties in combinations with other metals and against itself than any of the other metals we have tested*** – excluding, of course, hard facing alloys, which are not as economical to use."

"S" Monel, in addition to its non-galling characteristics, has the well-known properties and advantages of *all* INCO Nickel Alloys. ***It is strong . . . tough . . . fatigue resistant . . . corrosion resistant.*** It simplifies fabrication and offers economies in valve trim for high temperature service; it is an outstandingly efficient material for heat-treated engine castings, hot air scoops, fuel line fittings, pump liners, fuel and oil tank flanges, wing hooks, etc.

DO THIS – NOW

Get more information about extra-hard heat-resistant "S" Monel and other specialized valve materials. Write to R. F. Johnson, c/o The International Nickel Company, and ask him to send you INCO's valuable booklet, ***Trimming Valve Costs with Lasting Trim.*** It tells you how to make valves last longer, whether they handle live steam, hot chemicals, compressed air or corrosive cooling water. Send today for your free copy. A post card will do.

*Reg. U. S. Pat. Off.



SELECTED because of its superior hardness at high temperatures and its anti-galling properties, "S" Monel is now standard material for guiding sections (arrows) in this Manning, Maxwell & Moore Consolidated Safety Valve. Used in the hardened state, the "S" Monel parts cast at Inco's foundry are given a ground finish with an emery cloth polish prior to assembly.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

DEDICATED TO SERVICE
NICKEL (INCO) ALLOYS
MONEL* • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL
INCONEL* • NICKEL • "L" NICKEL • PERMANICKEL* • DURANICKEL* • INCONEL "X"
*Reg. U. S. Pat. Off.

19TH POWER SHOW

(Continued from page 98)

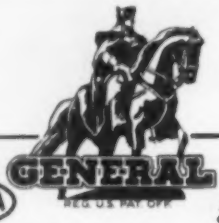
piston type check and stop-check designs.

Also educational in purpose will be the display of one of the great oil companies, featuring a model hydrostatic bearing and also a lucite model sleeve bearing, to demonstrate pressures developed by the rotation of the journal. Another visual demonstration at the same booth will be a plastic model turbine with a lubricating system revealing some spectacular developments in this important problem.

Another display will demonstrate how vibration control works, showing mountings for all industrial requirements, illustrating typical rubber-bonded parts so designed as to simplify assembly as well as improving product performance.

Stainless steel assemblies for jet aircraft and flexible high-pressure pipeline expansion joints capable of withstanding pressures up to 1500 psi will be featured in a display of stainless steel bellows and flexible hose.

New material of an entirely different class will be represented by bearings, bars and finished machine parts fabricated from metal powders of copper, bronze, iron, copper-iron, stainless steel, nickel silver and aluminum. Heavy duty porous metal bearings, because of their self-lubricating properties, will provide a continuous oil film and installed in a machine may never require subsequent lubrication.



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High grade gas, by-product, steam and household stoker coal from Wise County, Virginia, on the Interstate Railroad.

DENDRON

High grade gas, by-product, steam and domestic coal from Wise County, Va., on the Interstate Railroad.

STONEGA

High grade, high volatile steam and by-product coal from Wise County, Va., on the Interstate Railroad.

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A laboratory controlled product blended to meet exacting stoker requirements. From Wise County, Va., on the Interstate Railroad.

GLENBROOK

The Premium Kentucky High Splint unmatched for domestic use. Produced in Harlan County, Kentucky, on the L. & N. Railroad.

COKE

Roda and Stonega from Wise County, Va.

CRITERION COAL

High grade gas, by-product, steam and domestic coal—Pittsburgh seam from Irwin Basin, Westmoreland County, Pennsylvania, on the Penna. Railroad.

HAMPTON COAL

High volatile domestic, steam and by-product coal from Boone and Logan Counties, W. Va., on the Chesapeake & Ohio Ry.

CROZER

Genuine Pocahontas from McDowell County, W. Va., on the Norfolk & Western Railway.

LYNCO

High fusion coking coal for by-product, industrial stoker and pulverizer use from Wyoming Co., W. Va., on the Virginian Ry.

ANTHRACITE

Hazle Brook—*Premium Lehigh*
Raven Run—*Premium Mahanoy*

Capable engineering personnel and the experience gained through long and varied marketing activity assure proper application of one of the above brands and effective servicing of any fuel requirement.

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NEW YORK NORFOLK PITTSBURGH

The Push-Button Controls

In instruments and controls, remarkable advances have been made since the last Power Show in 1948. Great strides have been made in the production of individual instruments for indicating and recording temperatures, pressures, liquid levels, rates of flow, weights and measures and chemical analyses.

Most spectacular advances involve remote indication and control, several of which have placed process control, and even the operation of an entire power plant, literally under finger-tip control. Going even beyond the push-button control, one "integrated load-frequency combustion control" for the first time applies changes in electrical load directly to boiler regulation. Under this system, when the load on a power plant changes, a corresponding change is initiated in the combustion control equipment without waiting for a change in steam pressure to occur. This speeds up the response of boiler firing to variations in load demand.

Another exhibit that will have a first view at the Palace will be an electronic master control system, developed to solve the transmission problems created by control centralization in large plants. This system offers improved accuracy, speed of response, installation flexibility and smaller, simplified control panels with fewer moving parts.

Accompanying the growing interest in smoke abatement and fuel conservation, control systems to prevent smoke formation utilize a robot-eye that automatically holds the air-fuel ratio at a point where a thin haze, invisible to the human eye, is maintained in the breeching beyond the combustion chamber.

Illustrating a different phase of the instrument field is an exhibit featuring a pH recorder in package form, having all components housed in the recorder case, dissolved oxygen or hydrogen recorders, single and multi-point recorders for analyses of CO_2, H_2, CO, CH_4 and O_2 in flue gases. These instruments are of direct value in determining combustion efficiency and in observing rates of corrosion.

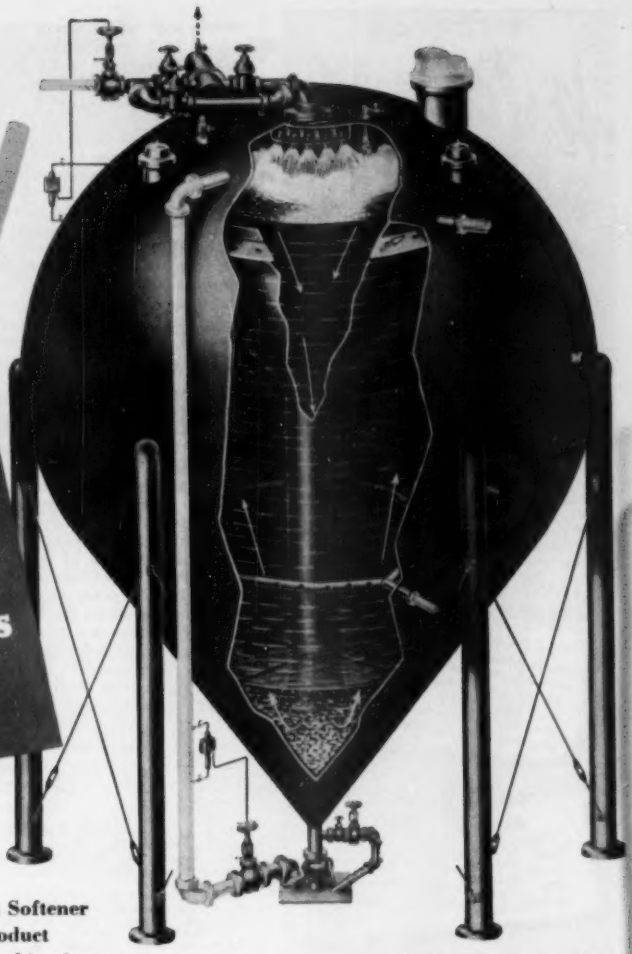
Power Plant Equipment Highly Varied

A new hydrostatic testing pump capable of building up a pressure of 25,000 psig will be shown, while a new "miniPump" which will handle clear liquids at the rate of a few cc per hour against pressures up to 100 psig is designed for the chemical treatment of boiler water, industrial water, municipal water and waste.

Spring-loaded safety and relief

New!

GRAVER SPHERICONE for Hot Process Softening . . .



An improved design for Hot Process Softener Sedimentation Tanks . . . another product made possible by Graver's unique combination of chemical engineering skill and tank fabrication experience. • The new Graver Sphericone has many functional and structural advantages over other designs of hot process softener sedimentation tanks:

❶ *Clearest softened water* . . . because the expanding settling zone provides maximum settling area and lowest rising rates. This assures minimum load on filters . . . saves operator's time and filter media replacement.

❷ *Most efficient use of materials and space* . . . because of the exclusive Sphericone shape.

❸ *Uniform stress distribution* . . . because of the virtual elimination of knuckle radii.

GRAVER

The new Sphericone is made in Graver's own shops, together with all the other major component parts of the Graver Hot Process Softener. Write today for complete data.

GRAVER WATER CONDITIONING CO.

Division of Graver Tank & Mfg. Co., Inc.

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GW 491

REPORT ON

Nalco SR 150 and 151

SLAG ALLEVIATION

Results

Here are typical examples of slag alleviation and soot removal with Nalco SR-Series Chemicals. All three plants have been using the treatment over a year . . . Read what they report!

"SAVING 60% ON SLAG TREATMENT"

"Good results with previous treatment—heavy slag formation without treatment. Nalco SR-150 tried on test basis . . . Results so excellent that SR-150 has been used ever since . . . with over 60% savings in slag and soot treatment costs."

"SLAG CEASED TO BE A PROBLEM"

"Nalco SR-151 Pellets fed with the coal . . . no longer necessary to shut down a boiler just for removing slag . . . which has ceased to be a problem here."

"SLAG DEPOSITS GREATLY REDUCED"

"Less than a week after starting Nalco SR-150 dosage, slag had decreased on bridge wall from 12 inches to 3 inches at top, from 2 feet to 8 inches at bottom . . . Slag on tubes was completely removed . . . Remaining bridge wall slag was quite friable and easily removed."

Today—now—is the time to get action on Nalco SR-Series Chemicals for your boiler furnaces. Write for details on SR-150 & 151 for coal firing . . . For oil-fired furnaces, ask for data on Nalco SR-153 the complete fuel oil additive.

NATIONAL ALUMINATE CORPORATION
6216 W. 66th Place • Chicago 38, Illinois
Canadian inquiries should be addressed to Alchem Limited, Burlington, Ont., Canada

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Serving Industry through Practical Applied Science

valves with bellows construction designed to form a flexible curtain to isolate guiding surfaces, springs and spring chambers from corrosive liquids and gases, will be shown. Latest advances in high-pressure, high-temperature cast steel valves for steam service shown by another manufacturer, are sealed by internal pressure to stay tight under all operating conditions. Heavy body-bonnet flanges, bolts and nuts of conventional valves are eliminated, the streamlined contour simplifies application and reduces cost of insulation. These valves have welded ends and are available in all commercial sizes in classes from 600-lb to 2500-lb. Small-sized integral bonnet steel valves for such services as high-pressure steam, feedwater, bypass, instrument and throttling are available in classes of 1500 and 2500 lb and in ½-in. to 2-in. sizes.

On display will be steam and Diesel engines, packaged boilers designed for high efficiencies, power transmissions, conveyor systems, material handling equipment in considerable variety.

Electrical apparatus to be seen include, on the power side, exclusive of signal systems and controls, a comprehensive assortment of direct drives, variable speed drives applicable to mechanical equipment of many kinds, as well as variable-speed transmissions applicable to synchronous motors. One exhibitor specializes in standby electrical generating plants for factories, hotels, airports, radio stations and public buildings.

One innovation will be a magnetic clutch, which is electrically controlled and shows no wear on the torque-transmitting surfaces. A line of magnetic amplifiers and photoelectric cells will form a part of the exhibit in which the new clutch is featured.

Machine tools and tool-room equipment on view will include metal and woodworking machines, measuring instruments, hand tools, designing and drafting equipment, as well as equipment suitable for the laboratory and model shop. Considerable space is also given over to maintenance equipment of modern design.

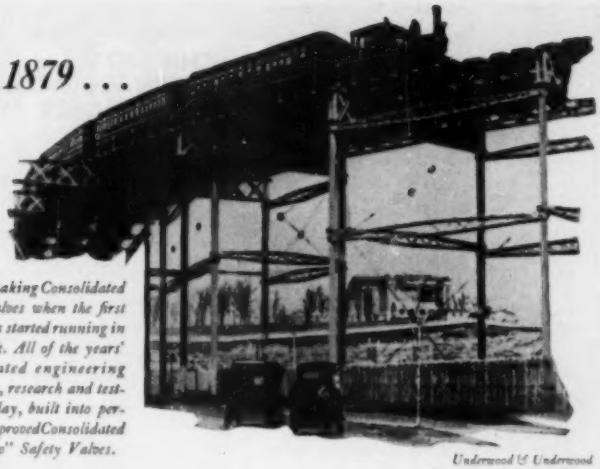
The Exposition will open Monday, November 27, at 2 p.m. and the hours daily are from 11 a.m. to 10 p.m. except Wednesday and Saturday when the closing will be 6 p.m. Admission is by invitation and registration only and is limited to executives, technical and operating men interested in power plant and allied equipment.

The Exposition is under the management of the International Exposition Co., of which Charles F. Roth is manager and E. K. Stevens, associate manager.

Preliminary List of Exhibitors
Grand Central Palace — New York
November 27-December 2, 1950

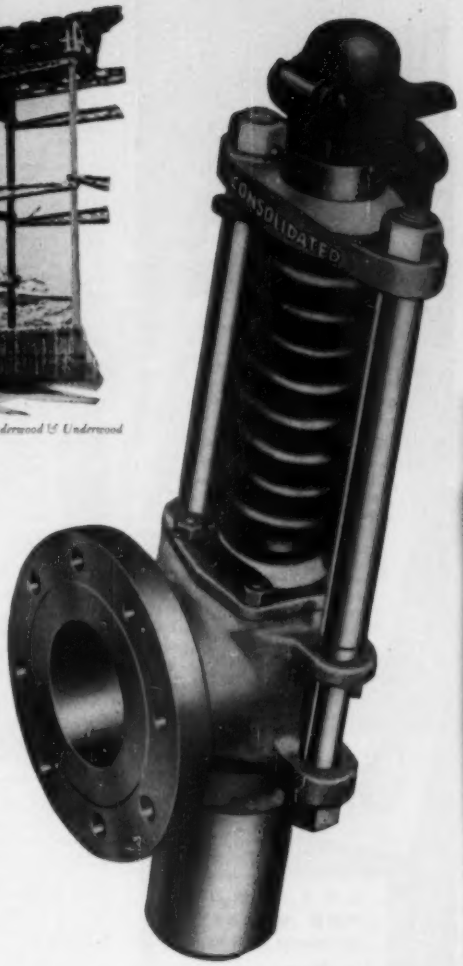
Aerodyne Atlantic Corp., New York, N. Y.
Aerotec Corp., The, Greenwich, Conn.
Allen-Bradley Co., Milwaukee, Wisc.
Allis-Chalmers Manufacturing Co., Milwaukee, Wisc.
Allis Co., The Louis, Milwaukee, Wisc.
American Brass Co., The, Waterbury, Conn.
American Chain & Cable Co., Inc., R-P & C Valve Div., Reading, Pa.
American Chain & Cable Co., Inc., Wright Hoist Div., York, Pa.
American Flexible Coupling Co., Erie, Pa.
American Hydrovac, Inc., Brooklyn, N. Y.
American Pulley Co., The, Philadelphia, Pa.
American Pulmax Co., Inc., Chicago, Ill.
American Society of Mechanical Engineers, New York, N. Y.
ASME Mechanical Catalog and Directory, New York, N. Y.
Ames Iron Works, Oswego, N. Y.
Ampco Metal, Inc., Milwaukee, Wisc.
Amplex Manufacturing Co., Subsidiary of Chrysler Corp., Detroit, Mich.
Anderson Co., The V. D., Cleveland, Ohio
Armstrong & Sons, Ridgefield, N. J.
Armstrong Machine Works, Three Rivers, Mich.
Armstrong Steam Trap Co., Three Rivers, Mich.
Arrow-Hart & Hegeman Electric Co., The, Hartford, Conn.
Ashton Valve Co., Wrentham, Mass.
Atlantic Gear Works, New York, N. Y.
Atlas Press Co., New York, N. Y.
Atlas Roller Chain & Mfg. Co., Philadelphia, Pa.
Atlas Valve Co., Newark, N. J.
Automatic Switch Co., Orange, N. J.
Bailey Meter Co., Cleveland, Ohio
Baltimore and Ohio Railroad Co., Traffic Dept., Baltimore, Md.
Barco Manufacturing Co., Chicago, Ill.
Barkelew Electric Manufacturing Co., Middletown, Ohio
Barrett-Cravens Co., Chicago, Ill.
Bean Division, John—Food Machinery and Chemical Corp., Lansing, Mich.
Beemer Engineering Co., Philadelphia, Pa.
Beloo Industrial Equipment Div., Inc., Paterson, N. J.
Beltran Associates Inc., New York, N. Y.
Berkroy Products Inc., Burbank, Calif.
Best Combustion Equipment Co., Inc., W. N., Carlstadt, N. J.
Biddle Co., James G., Philadelphia, Pa.
Black & Decker Mfg. Co., The, Towson, Md.
Black, Sivalls & Bryson, Inc., Kansas City, Mo.
Blackburn-Smith Manufacturing Co., Inc., Hoboken, N. J.
Bond Co., Charles, Philadelphia, Pa.
Bonner & Barnewall, Inc., New York, N. Y.
Boston Gear Works—Div. The Murray Co. of Texas, Inc., Quincy, Mass.
Botfield Refractories Co., Philadelphia, Pa.
Bowser, Inc., Fort Wayne, Ind.
British Industries Corp., New York, N. Y.
Brooks Shaper Co., New York, N. Y.
Brown Boveri Corp., New York, N. Y.
Brown Instruments Div. — Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.
Browne, William J., New York, N. Y.
Buell Engineering Co., Inc., New York, N. Y.
Buffalo Meter Co., Buffalo, N. Y.
Builders-Providence Inc., Providence, R. I.
Butler De-Scaler Corp., Jacksonville, Florida.
Cambridge Instrument Co., Inc., New York, N. Y.
Centrifuge Mechanical Equipment Co., Hoboken, N. J.
Chapman Valve Manufacturing Co., The, Indian Orchard, Mass.
Chase Chemical Corp., New York
Chicago Metal Hose Corp., Maywood, Ill.
Chiksan Co., Brea, Calif.
Clark Manufacturing Co., The, Cleveland, Ohio
Clements Mfg. Co., Chicago, Ill.
Cleveland Worm and Gear Co., The, Cleveland, Ohio
Cleworth Publishing Co., Inc., New York
Clinton Machine Co., Inc., Warner Div., Detroit, Mich.
Clipper Belt Lacer Co., Grand Rapids, Mich.
Coen Burner Sales Co., Weehawken, N. J.
Coen Co., Weehawken, N. J.
Commander Manufacturing Co., Chicago, Ill.
Condenser Service & Engineering Co., Inc., Hoboken, N. J.
Congress Drives Div.—Tann Corp., Detroit, Mich.

Since 1879 . . .



We were making Consolidated Safety Valves when the first "L" trains started running in New York. All of the years' accumulated engineering knowledge, research and testing is, today, built into performance-proved Consolidated "Maxiflow" Safety Valves.

Underwood & Underwood



There's over 70 years know-how built into CONSOLIDATED *Maxiflow* SAFETY VALVES

Maxiflow Safety Valves are new *in all that modern engineering can contribute.* But every feature of these valves has been proved by field experience over many years, and by long-time and severe testing methods.

In high pressure, high temperature installations, Maxiflow performance establishes a new standard in safety, efficiency and economy.

These Maxiflow design features mean important operating advantages:

Thermodisc Seat permits rapid equalization of temperature differentials. Thermal stresses are minimized, seat distortion cannot take place, permanent tightness is achieved.

Blowdown Control adjustable to a new, low minimum. The exclusive "micrometer" trim ring provides a simple and practical chatter-proof blowdown control, externally controlled and operable with valve under pressure.

Mechanical Through Bushing with precision machined surfaces that provide constant entrance conditions for steam flow. Eliminates leakage due to porous castings.

Retention of Popping Point is achieved by combining proper compensation with materials having low coefficients of expansion.

For complete description, plus capacity tables, write for the Consolidated Maxiflow Safety Valve Bulletin.

CONSOLIDATED *SAFETY* VALVES

A Product of

MANNING, MAXWELL & MOORE, INC.
BRIDGEPORT 2, CONNECTICUT

Makers of 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments, 'Hancock' Valves, 'Ashcroft' Gauges. Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load Lifter' Hoists, and other lifting specialties.

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Wherever flange and parallel surface joints must be connected for long trouble-free service—always select Belmont, the Better Sealing, longer lasting Sheet Packings.

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Crosby Steam Gage & Valve Co., Wrentham, Mass.
Cullman Wheel Co., Chicago, Ill.
Cutler-Hammer, Inc., Milwaukee, Wis.
Cyclotherm Corp., Oswego, N. Y.
DCMT Die Casting Machine Co., New York, N. Y.
DCMT Sales Corp., New York, N. Y.
Dake Engine Co., New York, N. Y.
Dampney Co. of America, The, Boston, Mass.
Danish Transmission Co., New York, N. Y.
Dayton Rubber Co., The, Dayton, Ohio
DeLaval Separator Co., The, New York, N. Y.
DeZurik Shower Co., Sartell, Minn.
Diamond Expansion Bolt Co., Inc., Garwood, N. J.
Doall Eastern Co., Inc., New York, N. Y.
Dowell Inc., Tulsa, Okla.
Drew & Co., E. F., New York, N. Y.
Durkee-Atwood Co., The, Minneapolis, Minn.
Duro Metal Products Co., Chicago, Ill.
Dykman Manufacturing Corp., New York, N. Y.
Eagle-Picher Sales Co., The, Cincinnati, Ohio
Eagle Signal Corp., Moline, Ill.
Edge Moor Iron Works, Inc., Edge Moor, Dela.
Edward Valves, Inc., East Chicago, Ind.
Elastic Stop Nut Corp. of America, Union, N. J.
Electra Motors, Inc., New York, N. Y.
Electric Controller & Mfg. Co., The, Cleveland, Ohio
Electrical World, New York, N. Y.
Elenite Products, Inc., New York, N. Y.
Elliott & Co., B., London, England.
Elliott Manufacturing Co., Binghamton, N. Y.
Energy Control Co., Inc., New York, N. Y.
Engineer Co., The, New York, N. Y.
Ernst Water Column & Gage Co., Livingston, N. J.
Everlasting Valve Co., Jersey City, N. J.
Fairbanks Co., The, New York, N. Y.
Fairbanks Morse & Co., Chicago, Ill.
Fairfield Engineering Co., The, Marion, Ohio
Falstrom Co., Passaic, N. J.
Famco Machine Co., Racine, Wisc.
Farris Engineering Corp., Palisades Park, N. J.
Farval Corp., The, Cleveland, Ohio
Federal Electric Products Co., Newark, N. J.
Fitz-U, Co., Great Neck, N. Y.
Flexitallic Gasket Co., Camden, N. J.
Foley Manufacturing Co., Minneapolis, Minn.
Food Machinery and Chemical Corp., John Bean Div., Lansing, Mich.
Foote Bros. Gear and Machine Corp., Chicago, Ill.
Foster Engineering Co., Union, N. J.
Foxboro Co., The, Foxboro, Mass.
Fuller Co., Catasauqua, Pa.
Furnas Electric Co., Inc., Batavia, Ill.
Garlock Packing Co., The, Palmyra, N. Y.
Gates Rubber Co., The, Denver, Colo.
General Chain & Belt Co., New York, N. Y.
General Controls Co., Glendale, Calif.
General Power Plant Corp., New York, N. Y.
Glasfloss Div.—Tilo Roofing Co., Inc., New York, N. Y.
Gordon Co., James T., New York, N. Y.
Graham Transmissions Inc., Milwaukee, Wisc.
Graver Water Conditioning Co.—Division of Graver Tank & Mfg. Co. Inc., New York, N. Y.
Greene, Tweed & Co., North Wales, Pa.
Grinnell Co., Inc., Providence, R. I.
Gulf Oil Corp., Pittsburgh, Pa.
Hahn-Pitz Corp., Brooklyn, N. Y.
Harbison-Walker Refractories Co., Pittsburgh, Pa.
Hays Corp., The, Michigan City, Ind.
Heacon, Inc., Philadelphia, Pa.
Heating, Piping & Air Conditioning, Chicago, Ill.
Hed-Wick & Co., Chicago, Ill.
Hilliard Corp., The, Elmira, N. Y.
Hills-McCanna Co., Chicago, Ill.
Homestead Valve Manufacturing Co., Coraopolis, Pa.
Howell Electric Motors Co., Howell, Mich.
Hungerford and Terry, Inc., Clayton, N. J.
Industrial Press, The, New York, N. Y.
Industrial Pyrometer & Supply Co., Alton, Ill.
Industry and Power, St. Joseph, Mich.
Institute of Patent Research and Development, Inc., New York, N. Y.
Insto-Gas Corp., Detroit, Mich.
Instrument Service Co., Hoboken, N. J.
Instruments Publishing Co., Pittsburgh, Pa.
Insulating Concrete Corp., Washington, D. C.

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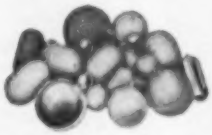

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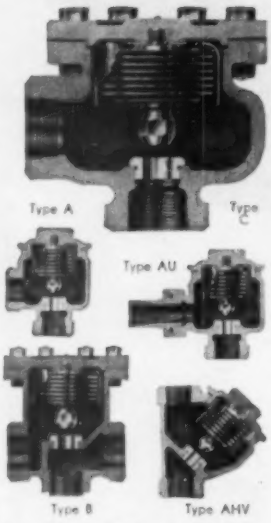

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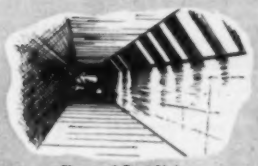

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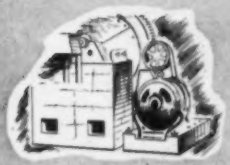

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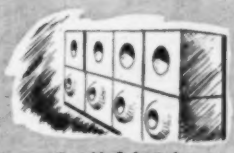

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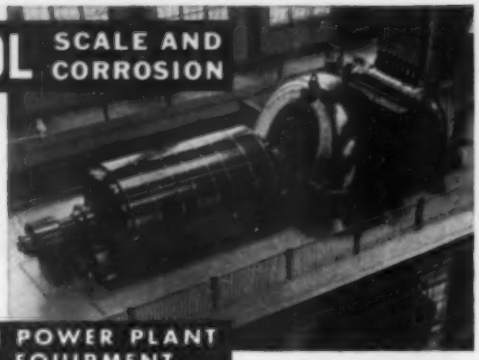

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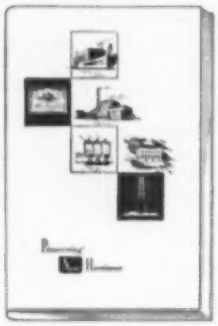

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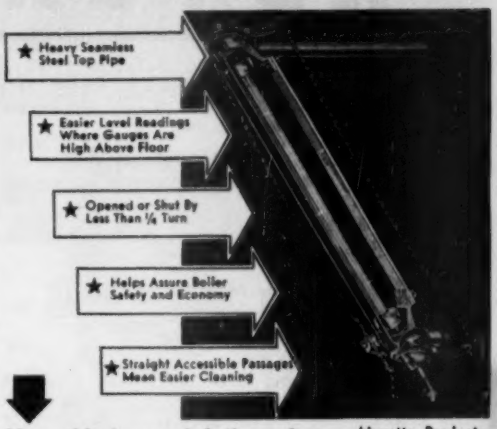
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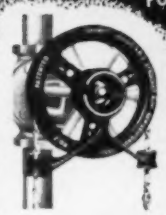

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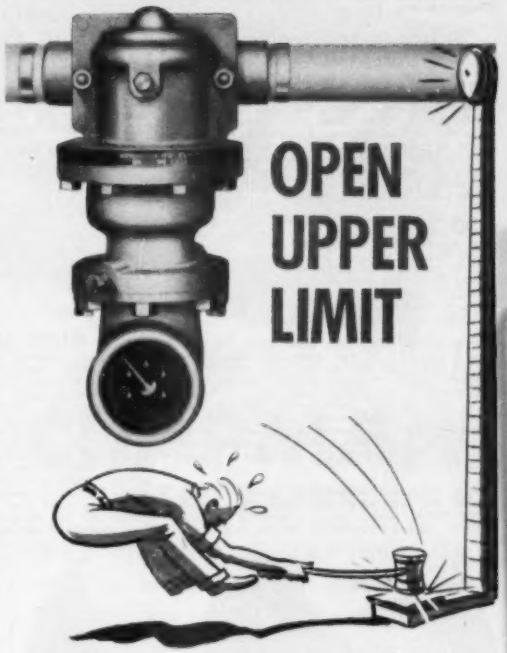
ANOTHER IMPORTANT FEATURE OF SHUNTFLO STEAM METER



Builders SMDH Shuntflo Steam Meter "rings the bell" wherever steam is used or sold. It totalizes *all* flow over a wide range and meters the heavy temporary overloads that come when steam is supplied to cold lines, tanks, etc. At these peak loads the Shuntflo Meter speeds up and measures excess rates up to 150% of normal capacity without damage to the mechanism. This "open upper limit" means you totalize every pound of steam delivered. A direct-reading totalizer shows within ±2% how many pounds of steam—or cubic feet of air or gas—have passed through the pipe line.

The Shuntflo Meter is widely used by district heating companies, process industries, and commercial buildings whose engineers must know *where* steam is consumed and *how much!* For complete information and new Bulletins 400-F1 and 400-F2, address Builders-Providence, Inc. (Division of Builders Iron Foundry), 385 Harris Avenue, Providence 1, R. I.

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The Venturi Meter

Chlorinizers — Chlorine Gas Feeders

BUILDERS PROVIDENCE *Instruments*

HELPFUL BULLETINS

(Continued from page 36)

cations are cataloged in 16-pp illustrated Bulletin 52R9016G. Units indexed include close-coupled, pedestal, double section single stage, multi-stage, self-priming, fractional horsepower, coolant and circulating, fire, process, solids handling, marine, rubber-lined, paper pulp, sewage, axial and mixed flow pumps. Head capacity charts and tables for various types of the pumps are given along with data on sizes, capacities and construction features. Allis-Chalmers Mfg. Co.

MECHANICAL POWER TRANSMISSION

129 **Data on Drives**—Book 2247, 16 pp, features company's new packaged power unit, the Motogear, but also describes and illustrates gear motors and separate helical drives. Discusses applications of the various drives, construction details, and methods of selecting a drive. Includes load classification selection data, dimensions, and separate 12-pp current price list. Link-Belt Co.

130 **Neoprene Belting**—This new single-sheet catalog section describes belting applicable for almost every type of light conveying and transmission service, and is particularly adapted to use in plants with high sanitary requirements. Gives complete details on applications, construction; includes a table of technical specifications. Baldwin Belting, Inc.

131 **Worm Gear Reduction Units**—Bulletin 130, 36 pp, describes company's Types AT and RT worm gear speed reducers which feature several recent improvements including face-type oil seals and new higher horsepower ratings. In addition to rating tables and dimensional data, booklet discusses construction features and includes operating information and selection tips. The Cleveland Worm and Gear Co.

132 **Miniature Speed Changers**—Bulletin 100 describes and illustrates small sized fixed ratio speed changers having higher ratios, precision gears and zero backlash. Covers single and combination units available, giving their applications. Includes standard integral ratios, dimensions, prices and discounts. Metron Instrument Co.

133 **Speed Reducers**—Engineering Bulletin 1115, 24 pp illustrated, covers a line of parallel shaft roller bearing speed reducers, telling how to select and order them. Includes horsepower rating and torque capacity tables, overhung load capacities, dimensions. Also gives data on backstops and couplings. The Falk Corp.

VENTILATING, DUST COLLECTING

134 **Exhauster Fan Data**—Illustrated Bulletin 5100, 20 pp, features performance data on company's industrial exhauster. Also discusses standard and special construction and available arrangements. Includes complete capacity tables, dimensions. Robinson Ventilating Co.

135 **Tubular Dust Filters**—The advantages, applications and construction details of company's tubular dust filters are given in Bulletin 24-D. Illustrated with photos and drawings, text covers both single compartment and automatic continuous multi-compartment units. Discusses in detail the bag shaker mechanism, dust discharge valve, dust hoppers, and housings, also additional equipment recommended in special cases, including pre-settling chambers, bag shaker timer control. Dimensions and capacity data included. Ruemelin Mfg. Co.

OTHER EQUIPMENT

136 **Unit Heater Code**—Recently-published Bulletin 10, the Standard Code for Testing and Rating Steam Unit Heaters, supersedes the first edition of 1930, prepared jointly by the Industrial Unit Heater Association and the American Society of Heating and Ventilating Engineers. The new second edition is issued under the same authorities. While fundamental engineering has not changed, improved testing equipment, instruments and technique have developed through the years and the purpose of the new edition is to recognize them. Industrial Unit Heater Association.

137 **The Why of Dual Circulation Generators**—The special advantages of company's dual circulation steam generator are presented clearly and factually in Bulletin B-50-11, 16 pp. Attractively illustrated with installation photos and sketches the text explains the principles of dual circulation. Tells the applications of this type of generator in both high make-up and low make-up plants. Stresses reduced carryover of silica and dissolved solids and reduced maintenance afforded. Foster Wheeler Corp.

138 **On pH Electrodes**—Catalog EN-85, 28 pp, is designed to help present users of company's equipment in ordering replacement parts and to guide new users in selecting the proper electrodes to solve their pH problems. It lists advantages of each type of electrode, and shows each assembly and all of its components in tabular form. Glass electrodes for industrial use are shown in detail for use in plastic, Pyrex or iron assemblies. Electrodes for laboratory use are also covered. Buffer solutions, chemicals, holders and mountings are listed, as are instruments used with electrodes. Leeds & Northrup Co.

139 **Tube Expander**—This 2-pp bulletin introduces a simplified tube rolling control for expanding condenser and heat exchanger tubing—a precision instrument for heavy duty service. Expander is illustrated and described; specifications and dimensions given. Crane Packing Co.

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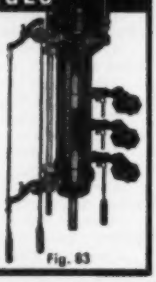

Fig. 83

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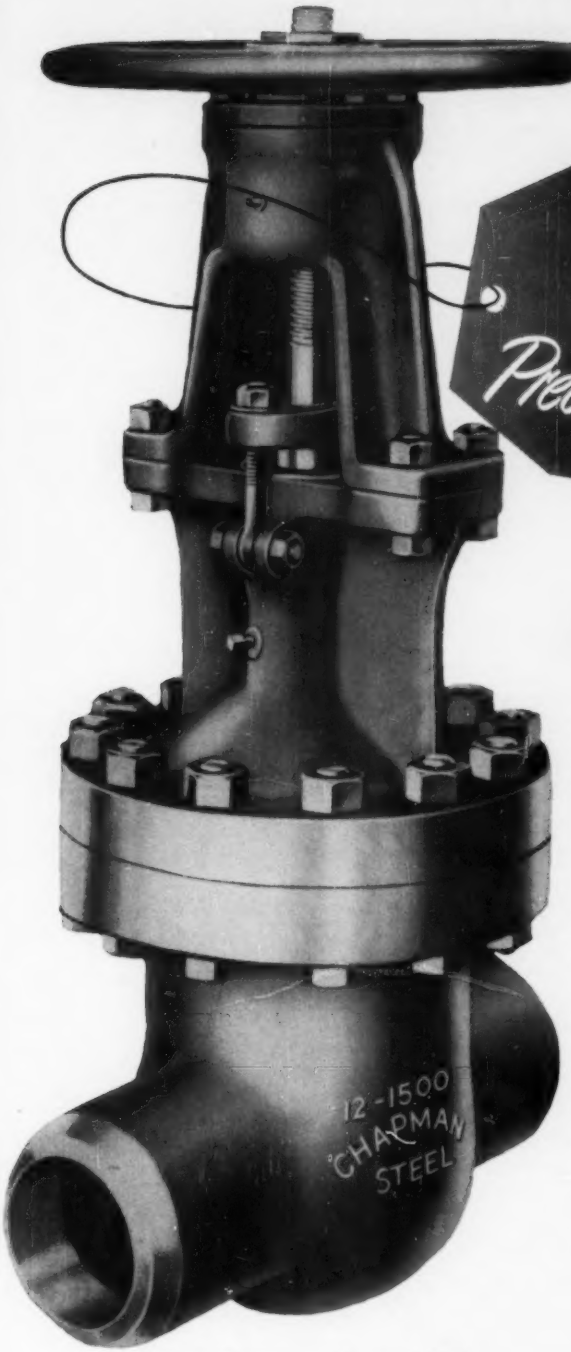

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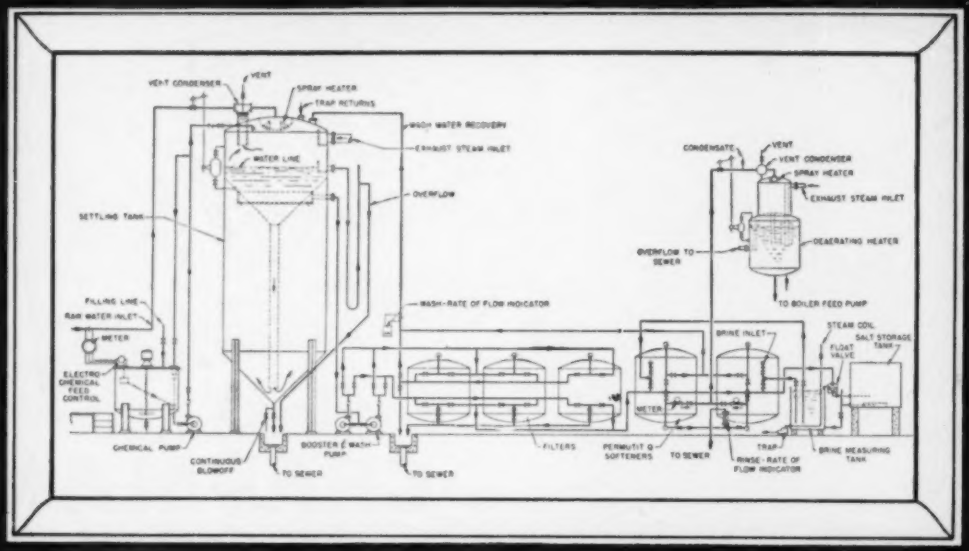

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